PRIL 15, 1918

NOTICE TO READER—When you finish reading this magazine, place a one-cent stamp on this notice, mail the magazine and it will be placed in the hands of our soldiers or sailors destined to proceed overseas. No wrapping—no address.

AVIATION AND AERONAUTICAL ENGINEERING

(C) Kadel and Herbert — Nieuport Fighter Going Aloft in France

OLUME IV
Number 6

PRICE
Fifteen
Cents

SPECIAL FEATURES

THE USE OF CORK IN AERONAUTICS
THE USE OF JIGS IN AIRPLANE MANUFACTURE
THE MODEL C.V ALBATROS BIPLANE
AIRCRAFT SITUATION FROM A MANUFACTURING VIEWPOINT
SENATE COMMITTEE RECOMMENDS SINGLE AIRCRAFT HEAD

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK

AIRCRAFT

TRADE MARK

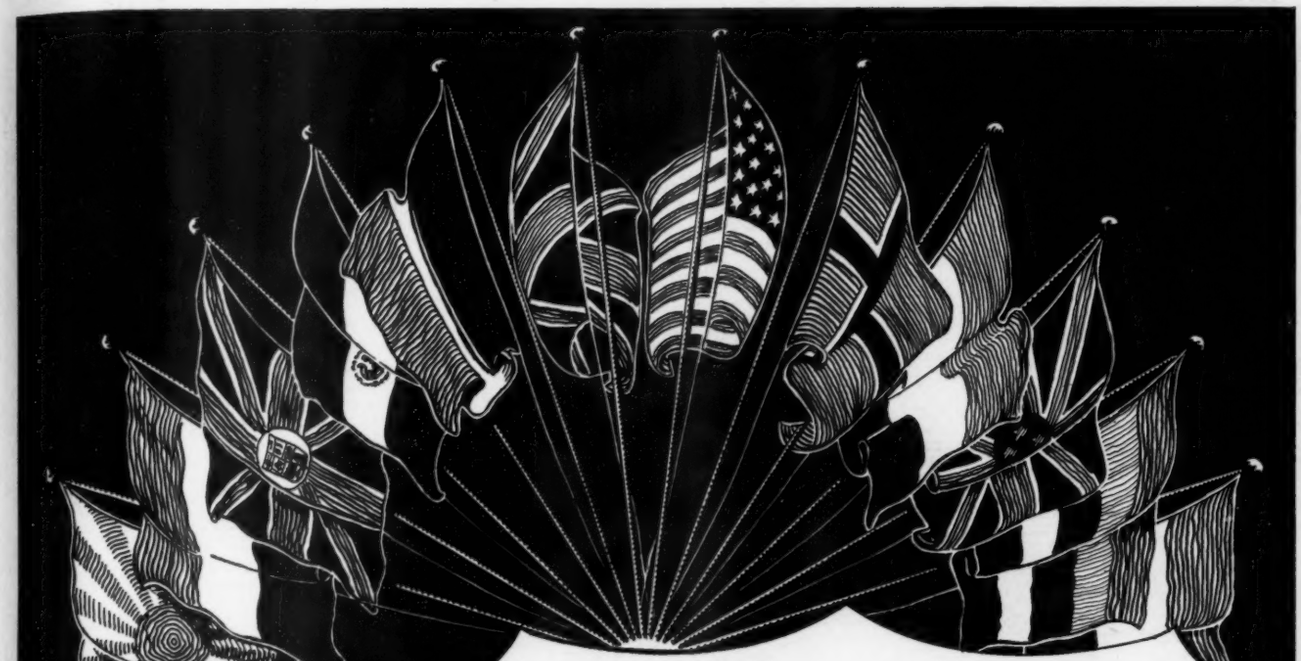
THE entire organization and skill, experience and ability of this company are devoted to intensive production in the interests of the United States for the period of the war.

WHEN peace comes Martin commercial and pleasure airplanes will maintain the supremacy of performance and dependability which they have held since 1909.

THE GLENN L. MARTIN COMPANY

CLEVELAND, OHIO

Contractors to the United States Government

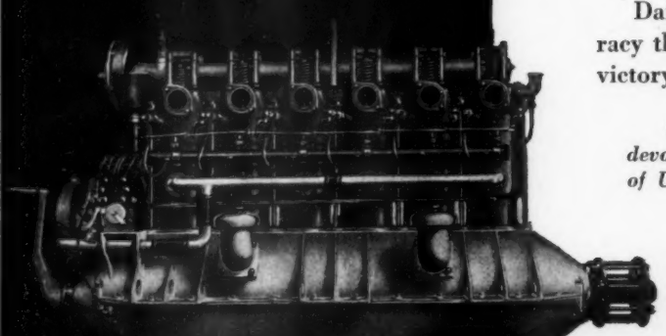


World Service

Hall-Scott 6 cylinder Airplane Engines have a distinctive record of service to Nations. In the blue field of the sky they are stars — fighting stars — for these world powers.

Daily Hall-Scott Engines serve democracy through Nations allied to bring a lasting victory for Humanity's sake.

Twenty-four hours each day this plant is devoting its entire energies to the production of United States Government orders only.



Hall-Scott Motor Car Company

Crocker Building San Francisco

HALL-SCOTT

CONTRACTORS TO

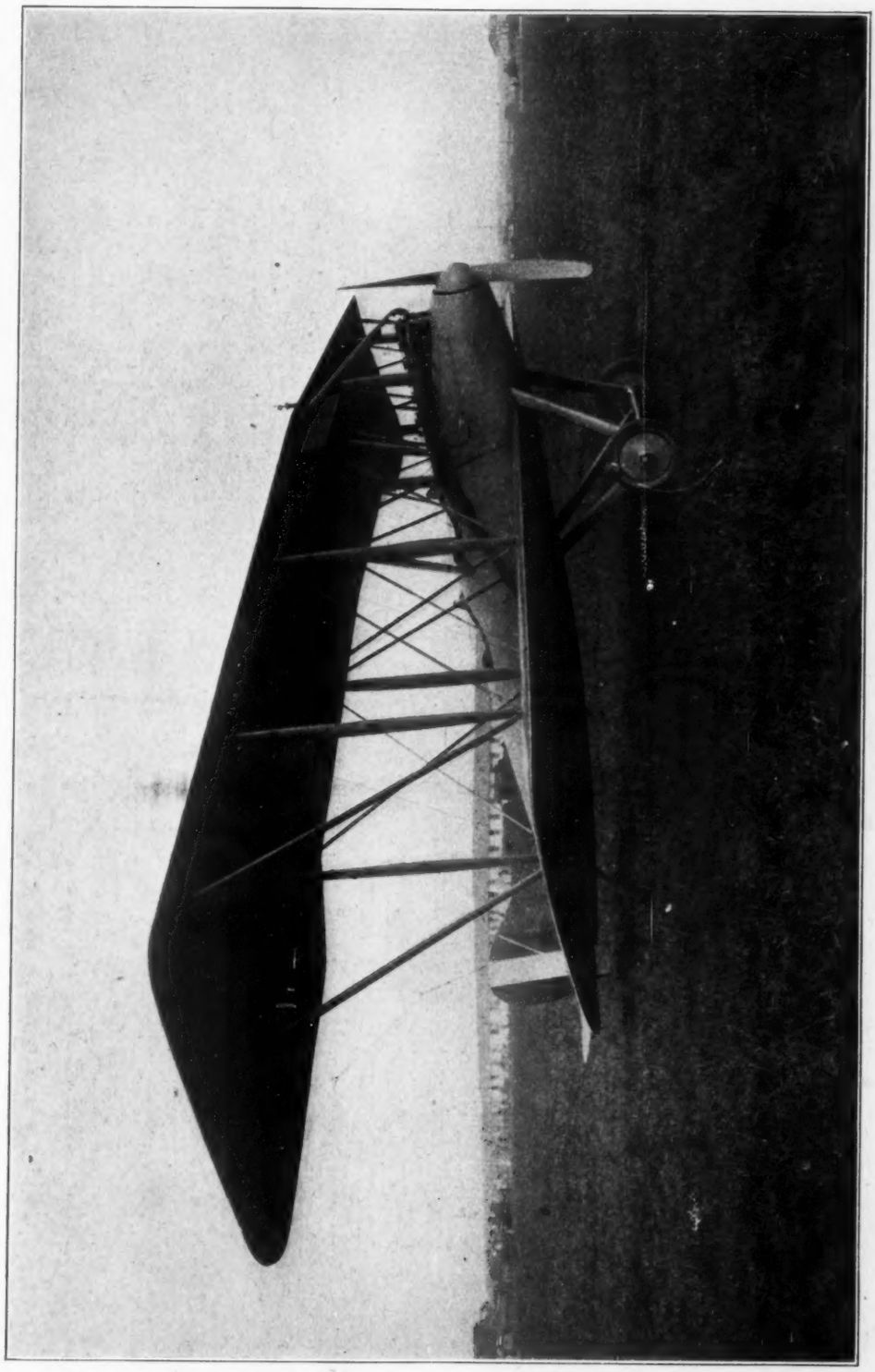
The United States Army and Navy

The British Admiralty

THE BURGESS COMPANY

MARBLEHEAD, MASS.

Sole Licensees for the United States for the Dunne Patents



L·W·F·ENGINEERING·COMPANY·
COLLEGE POINT, N. Y.

Duesenberg

The Power of the Hour

Airplane—Automobile—Marine Engines

The Aviator, the Ambulance Driver, the Naval Ensign, are all "Doing-Their-Bit" to finish the job of work before us all. The Duesenberg Motors Corporation is likewise doing its utmost to assist in finishing this same job of work. In order to better concentrate our resources on the work in hand for the United States Government we have withdrawn all our regular models from the market and our entire organization is working at top speed on its portion of the huge Airplane Construction Program.

Are You Doing Your Bit for the Liberty Loan?

DUESENBERG MOTORS CORPORATION, 120 Broadway, New York City

Contractors to the United States Government

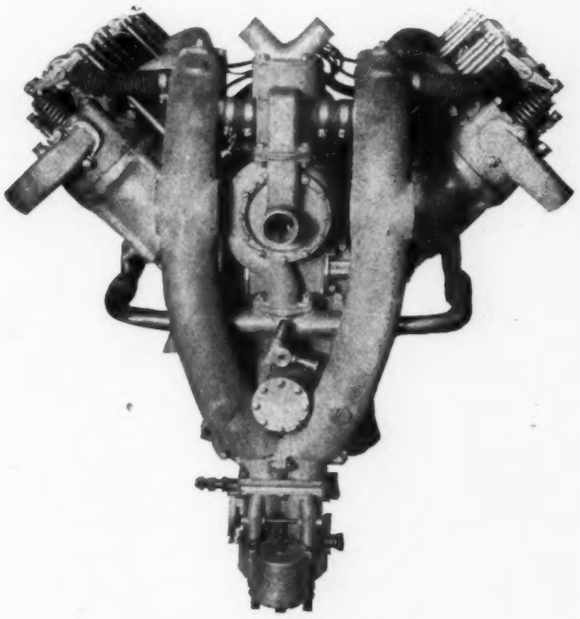
FLYING RECORD BROKEN

Sturtevant Establishes New Mark For Sustained Flight

A STURTEVANT engine, mounted in an L. W. F. Airplane exceeded all previous American records for sustained flight.

This flight was made with pilot, passenger and full military load, on March 27th, 1918 at Ellington Field, Houston, Texas.

Only after the last drop of fuel had been consumed, was the flight discontinued.



Sturtevant 210 H. P. Engine

Sustained Flight, Pilot and Passenger, 9 Hours 53 Minutes

Previous flying time of this particular engine 71 hours.

Cross Country Flight, Pilot and Passenger, 1357 Miles, Rantoul, Ill. to San Antonio, Texas — Time, 9 Hours 48 Minutes

Previous flying time of this particular engine 47 hours.

Sturtevant

REG. U. S. PAT. OFF.

B. F. STURTEVANT COMPANY

Hyde Park, Boston, Massachusetts

Member of the Aircraft Manufacturers' Association, Inc.

Where Your Money Goes

WE are now building more naval and merchant ships than we have constructed in the last generation.

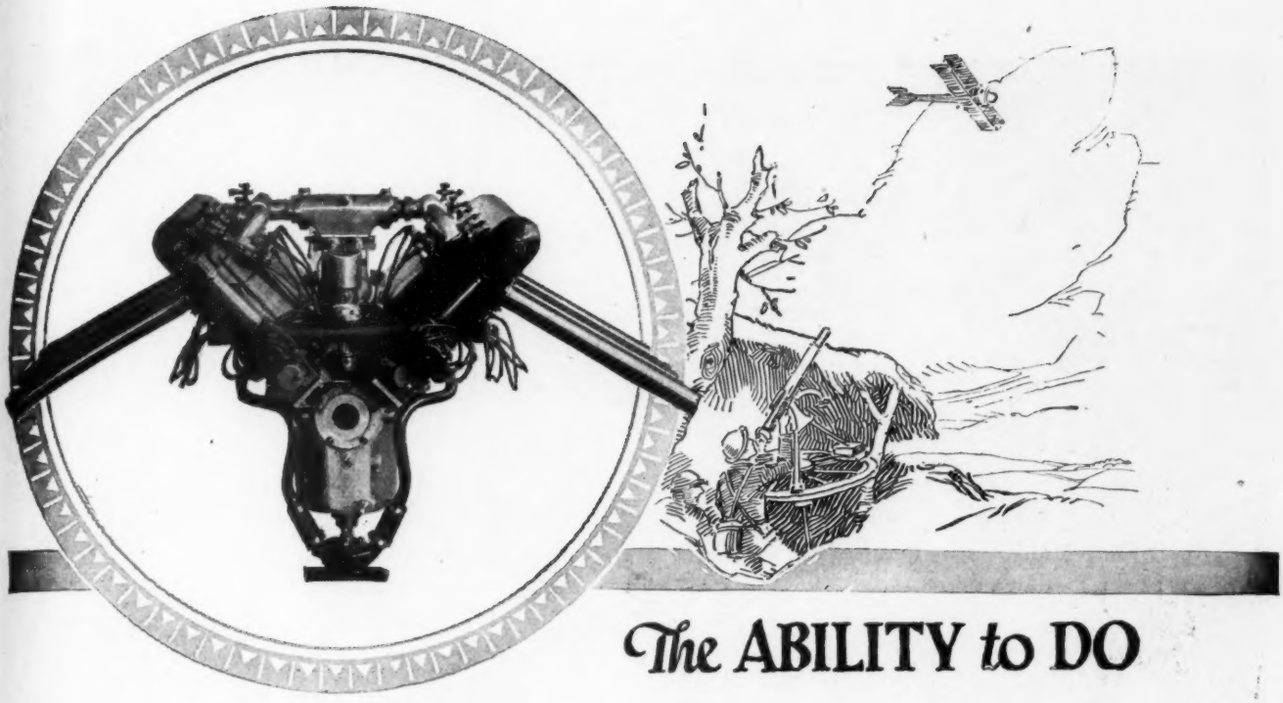
We are building a vast fleet of airplanes, and enormous supplies of artillery, motor trucks, machine guns, rifles and ammunition. We are feeding, clothing and training an army of a million men, and preparing for a million more. We have loaned billions of dollars to our allies, to be spent in the United States.

From the shipyards of the Pacific to those of the Atlantic; on our farms and in our mines, mills and factories in every state in the Union; back of the firing lines in France, where men are training, camps are being erected and railroads built, billions upon billions are being expended for labor, for transportation, for materials and supplies of every description.

The mind can hardly conceive the sums of money required for our war preparations. Yet these expenditures are absolutely essential. We must win the war quickly if possible; we must carry it on for years if necessary. We must do the job with American thoroughness, let the cost be what it may.

Remember, when you invest in your Liberty Bonds, that there is immediate, urgent, imperative need for every dollar you can possibly spare.

Wright-Martin
New Brunswick, New Jersey, U.S.A.
Aircraft Corporation



Hispano-Suiza Engine

The ABILITY to DO

AT a time when the manufacture of airplanes and engines is of such international prominence as at present, it is important to note the expansion of the Wright-Martin Aircraft Corporation under the leadership of men of known ability.

For the manufacture of the famous Hispano-Suiza engine for all types of airplanes, the character of the organization is noteworthy, supported as it is by the origination of the basic aviation patents.

Wright-Martin
Aircraft Corporation

New Brunswick, N. J., U. S. A.

3RD
LIBERTY
LOAN
2ND
LIBERTY
LOAN
1ST
LIBERTY
LOAN
"And there is a lot more up the river than has ever come over the falls."
Strauss & Buegeleisen
438 Broadway
New York

"COLUMN FOUR"

SETTLES IT

" A steel ball weighing 4 ounces was dropped on the surface of the glass from increasing heights until rupture occurred and then additional blows were delivered from this last height "

HERE FOLLOWS A TABULATION OF RESULTS

" COLUMN 4, therefore, represents the number* of blows delivered to the B type glasses before splinters flew from the rear of the glass."

Extract from BUREAU OF STANDARDS,
Report on UNSHATTERABLE GLASS,
No. 23004, March 25, 1918.

* The average in COLUMN 4 for 20 samples of Resistal is 24 additional blows from an average height of 9.5 inches.

The Glass that HAS this Record is SAFE for the Aviator

What Hasn't Is NOT

Avoid unnecessary risk by wearing

UNSHATTERABLE RESISTAL GOGGLES

Every Aviator wants the SAFEST Goggle

A complete copy of the Bureau of Standards Report will be sent on request

Write for catalog and free test pieces

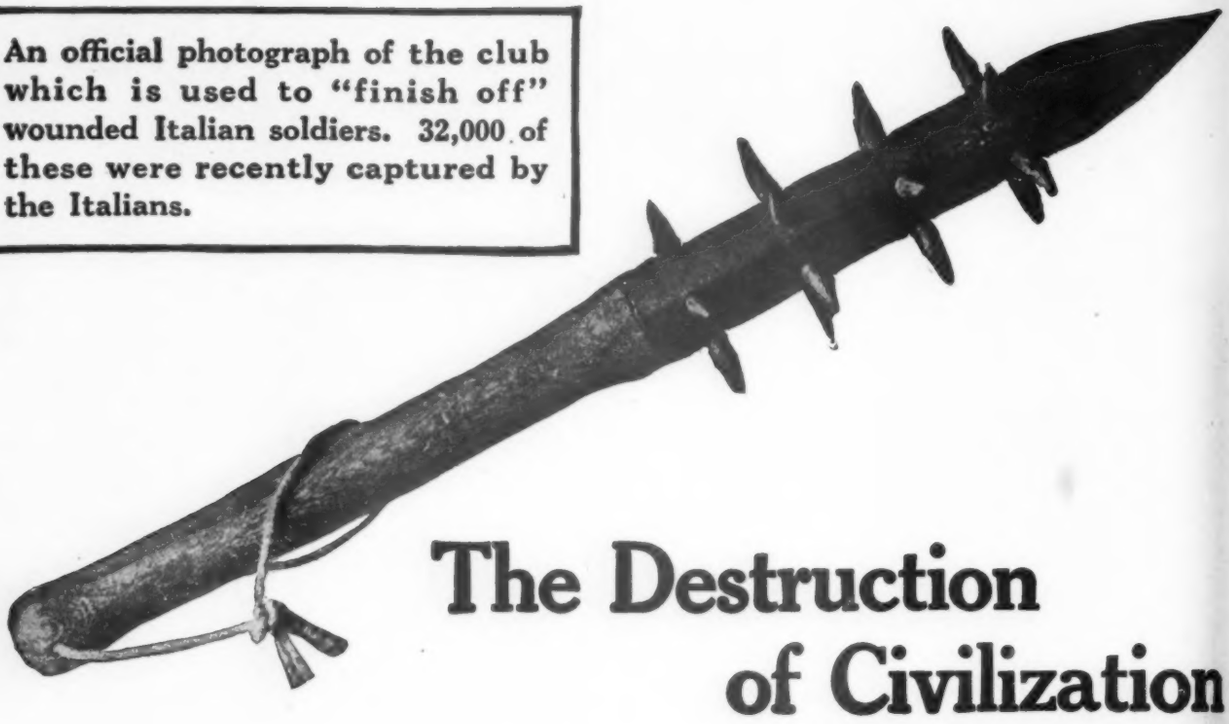
STRAUSS & BUEGELEISEN

Manufacturers

438 Broadway New York City

INSIST ON SAFETY

RESISTAL S.&B.N.Y.



An official photograph of the club which is used to "finish off" wounded Italian soldiers. 32,000 of these were recently captured by the Italians.

The Destruction of Civilization

is in grim and sober reality what we are fighting this war to prevent. The club pictured above—from an actual official photograph—might be the weapon of a savage cave man of five thousand years ago. It is in fact the weapon with which German soldiers "finish off" enemy wounded who have fallen on the battlefield.

There is only one answer to make to such methods—the defeat of the German armies. America has taken up the sword to give that answer. Our army is in France to help win this war on the battlefield—that civilization may be safe, that America may be safe.

You Can Have Your Share in America's Answer to German Savagery

The Third Liberty Loan is your opportunity. It is the most direct blow that can be struck at German military supremacy. It is the most powerful aid that can be given our soldiers in France. It means rifles and helmets and gas-masks—the best protection for our men from German brutality. It means big guns and shells and airplanes—and VICTORY.

Invest today in bonds of the Third Liberty Loan, and save the lives of American soldiers.

Save Civilization, Save America, Your Own Family and Your Own Home

In co-operation with the Liberty Loan Committee this advertisement is published by

SPLITDORF ELECTRICAL COMPANY

Newark, New Jersey

S K F

The Mark of a Quality Ball Bearing

THERE is no type of bearing that reduces friction so completely as a ball bearing, nor is there any other type of bearing that operates so efficiently as SKF. Don't use substitutes for ball bearings or substitutes for SKF.

SKF BALL BEARING CO.
HARTFORD 368 CONN.

SAFETY FIRST
SELF-ALIGNMENT

Automatically Self Aligning with Two Rows of Balls

Our army and navy are the protectors and the only protectors of *your* home—*your* family—*your* income—*your* property.

What will become of you and yours if these protectors are weakened and rendered insufficient to their task?

They will not be defeated by the enemy.

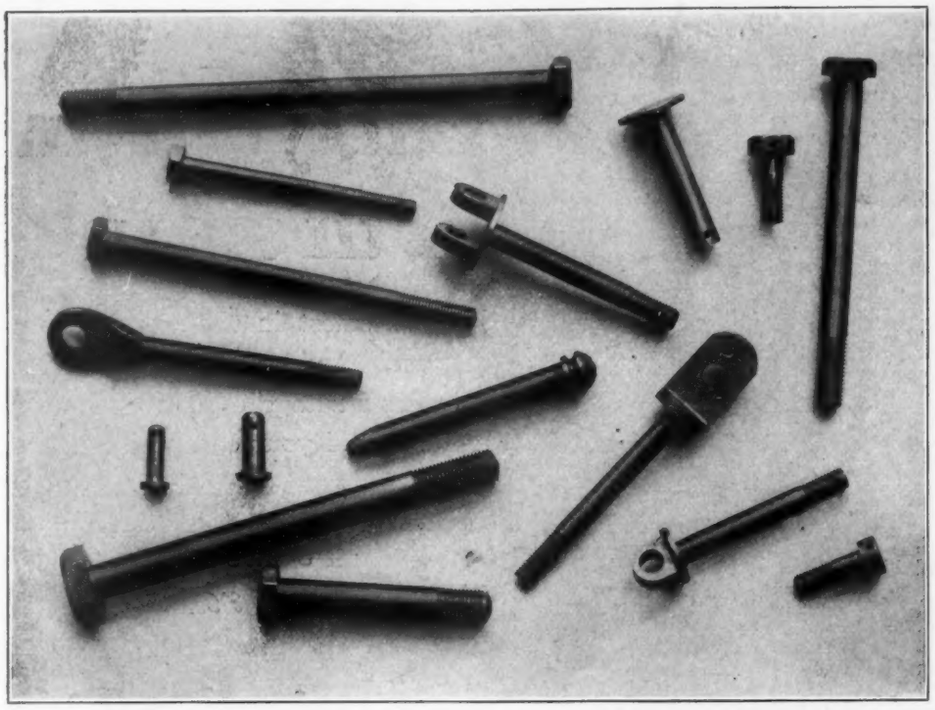
The only way they can be defeated or weakened is through *your* failure to support them with ships, food, weapons, ammunitions, clothing and supplies.

Your life, your business, the future of your family, may depend upon how much real effort and *sacrifice* you make to invest in

Liberty Bonds

In utilizing this advertisement to talk Liberty Bonds rather than our own business, we do so in the firm belief that there will be little of either pleasure or profit in our business or any American business unless Liberty wins this war.

SPERRY GYROSCOPE COMPANY
Brooklyn, New York



The parts shown on this page are used in AEROPLANE CONSTRUCTION —All being manufactured on AUTOMATIC MACHINES from our COLD DRAWN 3½% NICKEL STEEL.

When you desire

3½% NICKEL STEEL

which will be uniform in quality

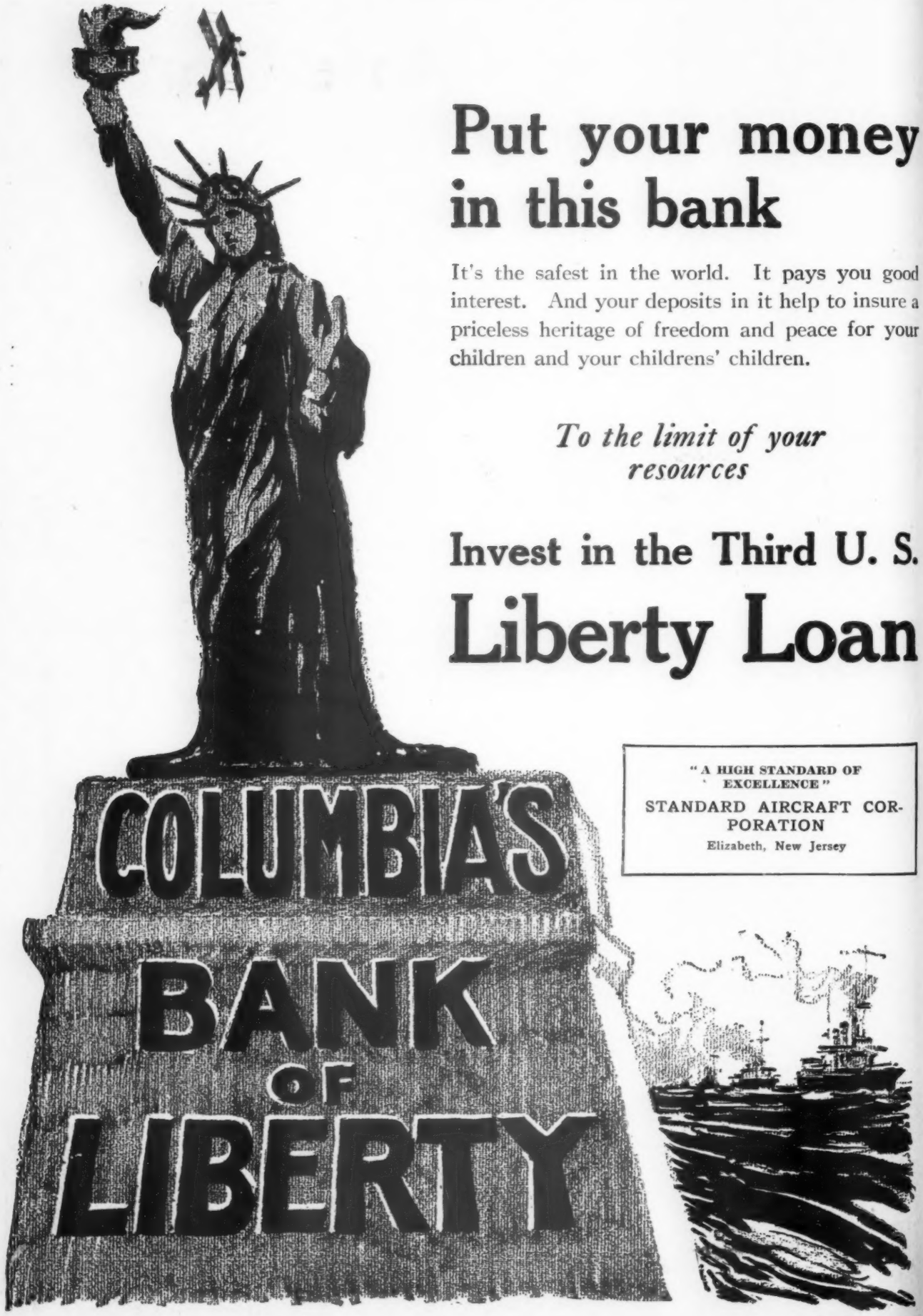
Write or Wire

SALES OFFICES
1001 Ford Bldg., Detroit, Mich.
801 Conover Bldg., Dayton, Ohio
617 Merchants Bank Building, Indianapolis, Indiana

The Betz-Pierce Co.
"STEEL OF QUALITY"
2230-40 East Ninth Street, Cleveland

SALES OFFICES
1308-9 Park Bldg. Pittsburgh, Pennsylvania
591 Ellicott Square Bldg. Buffalo, New York

A well assorted stock carried in Cleveland



Put your money in this bank

It's the safest in the world. It pays you good interest. And your deposits in it help to insure a priceless heritage of freedom and peace for your children and your childrens' children.

To the limit of your resources

Invest in the Third U. S.

Liberty Loan

"A HIGH STANDARD OF EXCELLENCE"

STANDARD AIRCRAFT CORPORATION

Elizabeth, New Jersey

More than Light Weight

When *Lynite* Pistons first began to supplant cast-iron in the airplane they were valued principally because they were three times as light. But important as is their advantage in weight, it is scarcely more important than another property which has come to be better and better appreciated.

This is the ability of *Lynite* to conduct heat twice as fast as cast-iron.

The extremely high temperatures encountered in airplane-piston service make the remarkable thermal efficiency of *Lynite* most valuable.

Piston Head Stays Cooler

Because the heat is carried to the cylinder walls much more rapidly, the head of a *Lynite* Piston is comparatively cool when that of cast-iron pistons would be red hot. This reduces carbon and the danger of pre-ignition. Thus it enables the engineer to increase compression and effect fuel economy.

This thermal efficiency also means a great reduction in carbon deposit not only on top but also underneath the piston head, from which it would drop into the oil in the crank-case.

With *Lynite* Pistons, it is possible to operate efficiently under conditions that no cast-iron piston could meet, for with cast-iron pistons in the cylinders the temperature would be excessively high.

Many Other Lynite Advantages

To secure the same degree of heat conductivity with cast-iron, it would be necessary to make pistons not three times but six times the weight of *Lynite* Pistons. In most cases, of course, this would be impossible. Even where it could be done, it would mean showing up in still stronger color all the advantages of *Lynite*.

It would mean increasing the size of connecting rod, crankshaft, bearings and other parts, resulting in a larger, more costly engine.

It would mean lowered engine-speed.

It would mean much greater vibration, with all its consequent disadvantages.

It would mean increased bearing pressures.

Superior cooling quality is one of the major reasons for the use of *Lynite* Pistons by Curtiss, Hall-Scott, Thomas-Morse, Duesenberg, Kessler and other airplane and aviation engine makers, as well as by many automobile builders.

For brass and bronze castings of all kinds, including bushings and bearings, use Lynux Alloys. Made in the most scientifically operated foundries in the country.

THE ALUMINUM CASTINGS COMPANY
LYNITE and LYNUX Castings
Cleveland Detroit Buffalo Manitowoc, Wis.
Fairfield, Conn.
Address Dept. 144, Cleveland

LYNITE PISTONS

Worth Fighting For?

SHALL this little girl grow up in the sort of American home we know, healthy and happy? Shall she have the advantage of living and learning in a free land, under free institutions? Shall such children develop into Liberty-loving citizens that a free America may be proud of?

For over two hundred years Americans have fought valiantly, and died gallantly, to win for themselves and hand down to their posterity the blessings of liberty, justice, self-government and equal opportunity. This precious heritage, bought at so great a price, is now threatened.

The question which today confronts America as a nation, and you as an individual, is whether or not a free America is worth fighting for

Are American children in this and all future generations to receive unimpaired the legacy of freedom of which we are now the custodians, or shall their country be turned over bodily to the brutal, rapacious, power-mad enemy which has forced us into this war?

This question cannot be answered by word of mouth, but by deeds alone.

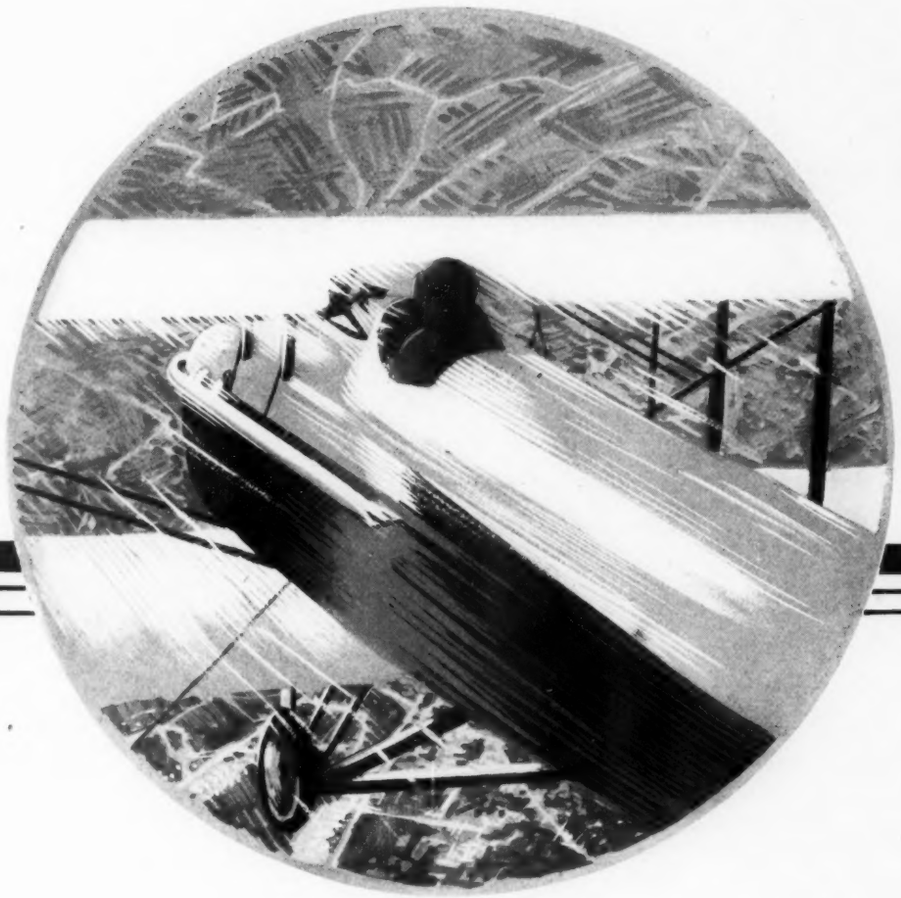
Let your answer be your investment in

Liberty Bonds!

In co-operation with the Liberty Loan Committee this advertisement is published by

GROVER C. LOENING

45 Eleventh Street Long Island City, N. Y.



We manufacture the following parts for airplanes

All Standard Types of Turnbuckles Tie Rods and Clevises Thimbles Bolts and Clevis Pins

THE

DAYTON METAL PRODUCTS CO.

DAYTON, OHIO, U. S. A.

YOU are asked to save every cent not needed for your reasonable support and physical well being—this is thrift

Bonds Are Not A Burden But A Blessing

THRIFT requires the exercise of restraint and self-denial—qualities without which you cannot achieve the success in life which it is your ambition to achieve, and for the lack of which you are likely to suffer in later years.

The money you acquire by thrift you are asked to loan—not give—to your country. It will come back to you when you may need it far more than you do now, and you will be paid interest for its use.

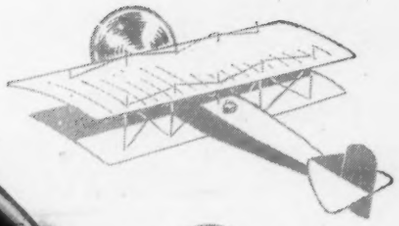
This war is a frightful thing, but it may prove of inestimable benefit to you, if it teaches you the good habit of thrift. Start the habit by investing in

Liberty Bonds

In co-operation with the Liberty Loan Committee this advertisement is published by

L. W. FERDINAND & COMPANY

Boston, Massachusetts



FIRST—

in War as in Peace

The leading Aeroplane builders of America use Fedders Radiators as standard factory equipment, just as—

A great majority of the leading American passengers cars and motor trucks are regularly equipped with Fedders Radiators year after year.

Let Fedders help solve your problems with this new Radiator—designed expressly for Aeroplane service.

We are especially prepared to make prompt shipments on any desired quantity of JN4D and JN4H radiators.

FEDDERS MFG. CO., INC.,
Buffalo, New York

FEDDERS
RADIATORS

Will You Invest Your Money With Uncle Sam Now?

Or Let Germany Take It Away From You Later?

Be practical. Look squarely at the facts. We will either invest our money with Uncle Sam now, at good interest rates, to help him win this war, or we will give it up later to pay Germany's war cost—and as much more as Germany chooses to collect. **Invest in**

Liberty Bonds Today

In co-operation with the Liberty Loan Committee this advertisement is published by

The Fafnir Bearing Co.

New Britain, Conn.

LIVINGSTON RADIATORS

Livingston Aeronautical Radiators

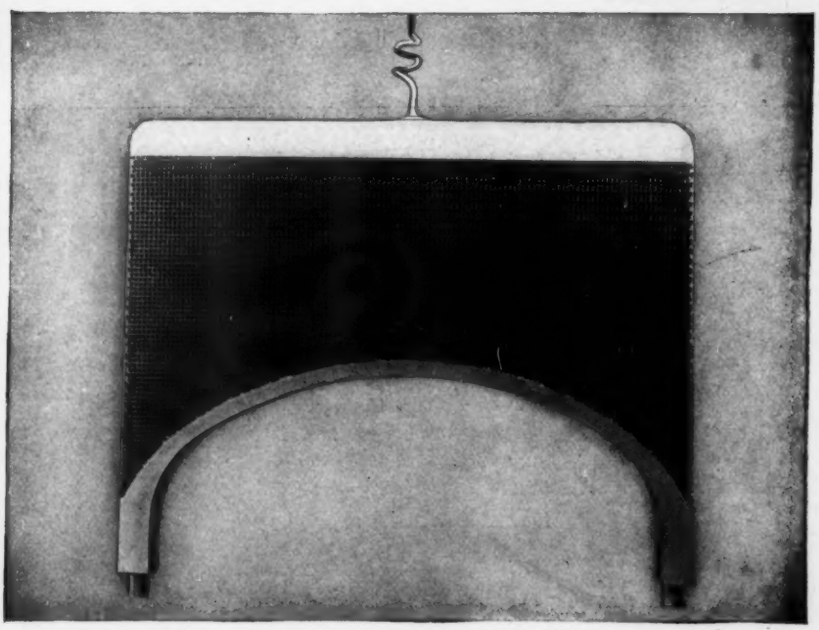
We manufacture radiators for all types of aeroplanes

Our engineering department is at your service

LIVINGSTON RADIATOR & MFG. CO.

ESTABLISHED 1903

75th Street and Amsterdam Ave.
New York City



He says we are bluffing!
Let's show him a big Card —
and everybody in on the Pot.
Put up your ante now in the
3RD
LIBERTY
LOAN
3rd LIBERTY LOAN
2nd LIBERTY LOAN
1st LIBERTY LOAN
WM. HARLAND & SON
Varnish Makers since 1791
Manufacturers of
AIR-SPAR

QUEEN INS. CO.

OF AMERICA, 84 William Street, New York City

Established 1891

Fire, Automobile, Sprinkler Leakage, Windstorm, Explosion, Use and Occupancy

INSURANCE ON AIRPLANES and SEAPLANES

THIS is a floating policy, covering the plane while in flight, or upon the earth, or in any building, or in or upon any inland body of water, or in or over the coastal waters in the United States, excluding Alaska, Porto Rico and Hawaiian Islands, against the risk of fire; also covering the plane while being shipped in any conveyance by land or water, within the limits of the policy, against the burning, sinking, derailment or collision of the conveyance.

STATEMENT JANUARY 1, 1918

Total Assets	$13,422,862.51
Liabilities	9,190,793.64
Net Surplus	4,232,068.87
Capital	2,000,000,00
Net Surplus to Policyholders	6,232,068.87

New York Department - - 84 William Street, New York Marine Department - - - 84 William Street, New York

Western Department, Chicago, Illinois

Southern Department, Atlanta, Georgia Pacific Coast Department, San Francisco

To Save the Lives of Our Brothers and Sons
Invest in U. S.
Liberty Bonds
The supremely important business of America now is to win this war.
Barcalo Manufacturing Co.
Buffalo N. Y.

COMPLETE
Engineering and Construction
SERVICE

This Corporation offers an exceptionally complete and comprehensive service in the designing, engineering and construction of manufacturing and industrial plants.

Our Organization is composed of experts of broad experience in industrial development work throughout the entire world. Our Construction Department is at present engaged on the construction of the Langley field and other aviation fields for the United States Government, and we are in position to offer clients a prompt and efficient service in the execution of any type of work involved in the engineering and construction of aviation fields or airplane factories.

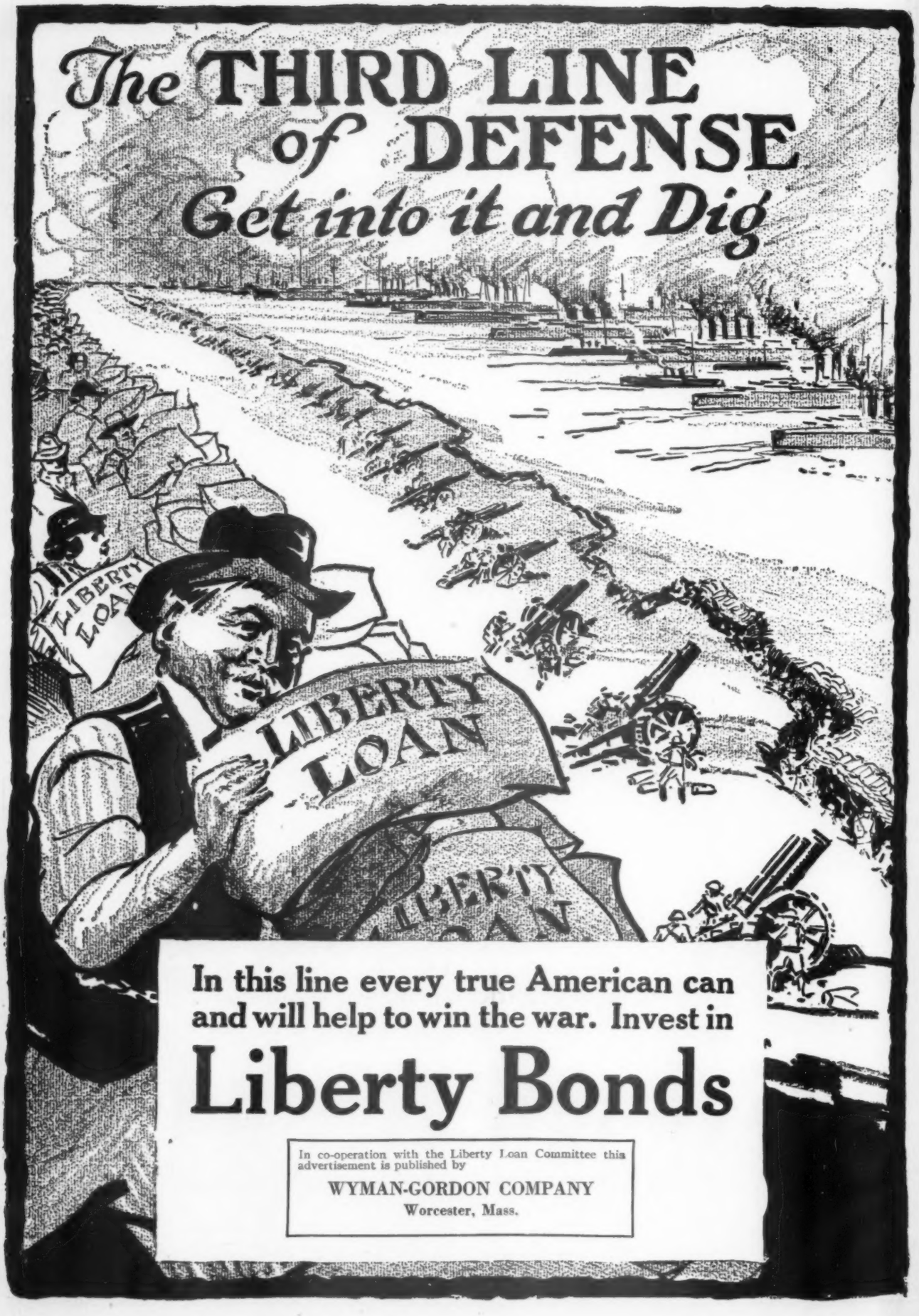
We are also prepared to make expert investigations and reports on going factories, with recommendations concerning possible improvements or extensions to increase operating efficiency.

We solicit inquiries on engineering or construction problems.

THE J. G. WHITE ENGINEERING CORPORATION

43 Exchange Place, New York

LONDON **CHICAGO**


The THIRD LINE of DEFENSE
Get into it and Dig
LIBERTY LOAN
LIBERTY LOAN
In this line every true American can and will help to win the war. Invest in
Liberty Bonds
In co-operation with the Liberty Loan Committee this advertisement is published by
WYMAN-GORDON COMPANY
Worcester, Mass.

NEW ENDURANCE RECORD

Established by

Union Airplane Motor at U. S. Aeronautical Testing Laboratory, Navy Yard, Washington, D. C.

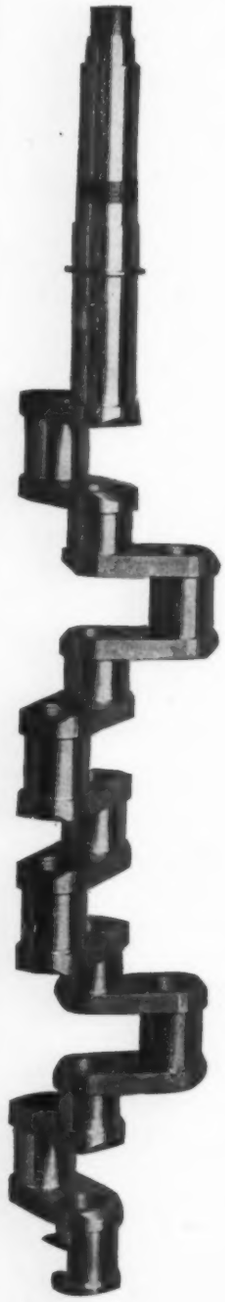
Best previous record exceeded by fifty per cent.

UNION GAS ENGINE COMPANY

ESTABLISHED 1885

OAKLAND - - - CALIFORNIA

CRANKSHAFT QUALITY



Stands out as the one requirement today of the builder of

AIRCRAFT and HIGH DUTY ENGINES

Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

UNQUESTIONED RELIABILITY

Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Careful attention to all orders; deliveries without delay.

WYMAN-GORDON COMPANY
WORCESTER, MASS.

"NORMA"

"NORMA" BALL BEARINGS

(Patented)

The highest speeds in an airplane—many times the speed in any other part—are carried by the magneto and lighting generator. At high airplane speed, the speed of these accessories may reach tremendous figures. Is further argument needed to demonstrate the vital necessity of speedability in ignition and lighting apparatus?

For years past, in America and abroad, in the magnetos and lighting generators invariably identified with cars, trucks and airplanes of notable dependability "NORMA" Ball Bearings have been the standard bearings. Their preeminence in this field is the result of an unbroken record of satisfactory performance.

Be SURE—See that your Electrical Accessories are "NORMA" Equipped

THE NORMA COMPANY OF AMERICA
1790 BROADWAY NEW YORK

Ball, Roller, Thrust and Combination Bearings.

"NORMA"

APRIL 15, 1918

AVIATION AND AERONAUTICAL ENGINEERING

VOL. IV. NO. 6

Member of the Audit Bureau of Circulations
Member of the Associated Business Papers, Inc.

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THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET, NEW YORK
WASHINGTON OFFICE, 310 EVENING STAR BUILDING

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR. COPYRIGHT, 1918, BY THE GARDNER-MOFFAT COMPANY, INC.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

Security in AIR COMPASS Construction

CREAGH-OSBORNE

Oscillations Lessened by Liquid Mounting

No Gimbal Rings

Accurate

VERTICAL TYPE

Vibrations are not Transferred to card

Big Heeling Angle

Reliable

THE SPERRY GYROSCOPE COMPANY
Manhattan Bridge Plaza
BROOKLYN, N. Y.

PARIS: 126 Rue de Provence
LONDON: 15 Victoria St., S.W.

MY SOLDIER

Now I lay me down to sleep
I pray the Lord my soul to keep.
God bless my brother gone to war
Across the seas, in France, so far.
Oh, may his fight for Liberty,
Save millions more than little me
From cruel fates or ruthless blast,—
And bring him safely home at last.

BUY WAR SAVINGS STAMPS

COMPLIMENTS OF
CURTISS AEROPLANE AND MOTOR CORPORATION

W.S.S. W.S.S.

W. J. MOFFAT
PRESIDENT
W. I. SEAMAN
TREASURER

AVIATION
AND
AERONAUTICAL ENGINEERING

H. M. WILLIAMS
MANAGING EDITOR
LADISLAS D'ORCY
ASSOCIATE EDITOR
GEORGE NEWBOLD
BUSINESS MANAGER

Vol. IV | April 15, 1918 | No. 6

The Use of Cork in Aeronautics

By Arthur K. Barnes
Armstrong Cork Co.

Designers, builders, and users of aircraft have all gained materially by the experience of men who have played an important part in the development of the internal combustion engine as used in the automobile industry. Each material which enters into the construction of gas engines has played its part toward making those engines give more dependable performance and last longer than they formerly did.

While gaskets may not be considered as relatively important in motor construction, they at least deserve the careful consideration of engineers who desire to eliminate the leakage that is so common where ordinary fibrous materials are used. For this reason, it may be well to see just how cork has become a factor in the automobile field, and promises to become equally important in aeronautics. Cork has for a long time been manufactured into specialties for motor cars and its success in this field is best evidenced by the growing use of cork floats for carburetors, gasoline tanks, oil gauges, and cork composition gaskets and washers. Remarkable progress has been made in the development of cork compositions which would prove satisfactory in all cases where the temperature did not exceed 212 deg. F. To be satisfactory in service, such a material has to be impervious to oil, gasoline, grease and water, so that it may be kept in contact with these liquids for a long time without losing its effectiveness as a sealing agent.

THE OAK CORK—A NATIVE OF SPAIN AND PORTUGAL
THE OUTER BARK OF THIS TREE IS THE CORK OF COMMERCE

Cork Composition Gaskets

The natural elastic properties of cork are increased in the manufacture of cork composition gaskets, and this quality makes them especially efficient when used between rough, uneven surfaces. Therefore, where cork gaskets are employed, it is unnecessary to machine the flanges of the castings, or pressed steel stampings. The elasticity of cork gaskets is permanent, since age will not harden the material. Furthermore, cork is naturally non-absorbent and will not became saturated by the action of liquids. It is unnecessary to exert excessive pressure on these gaskets to insure tight joints. With fibrous materials, which are admittedly absorbent, seepage is bound to occur, regardless of how tight a joint may be pulled up. Since oil leakage is a recognized source of expense and annoyance, and the users of gas engines have come to demand tight joints, the use of cork gaskets has been found to be a most inexpensive and, at the same time, a most efficient remedy for this trouble, especially where pressed steel pans and covers are employed.

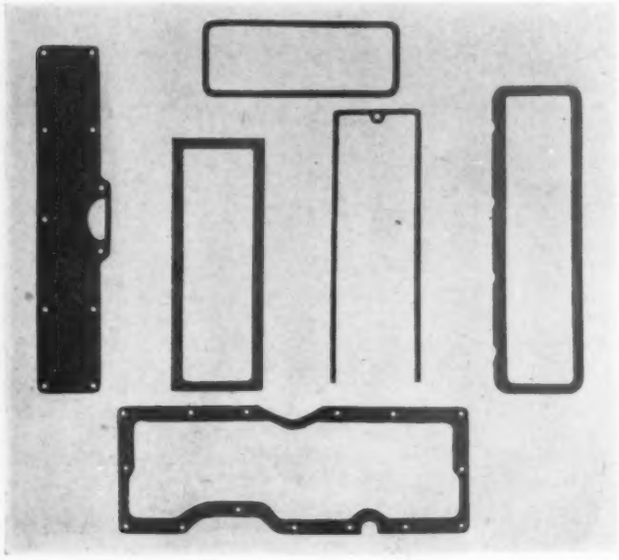
The constant resilience of cork to pressure has the effect of a lock washer in keeping the bolts tight. As a result, motors equipped with cork gaskets are free from the rattle which often develops from vibration. This is more noticeable, of course, in high-speed motors such as are necessary for aviation purposes. Then, too, fewer bolts and bolt holes are required because very smooth surfaces and excessive pressure are not needed. This condition is doubly advantageous, as it gives greater strength to the metal parts and eliminates considerable machining and assembling work. The savings thus effected are often sufficient to make up for the additional cost of the gaskets themselves.

One of the most successful uses of cork gaskets has been between crank case and oil pan. These gaskets should be thick enough to make a good fill between bolt holes with a moderate amount of compression. Extra pressure may be added if desirable, since the cork will compress to the thickness of paper around the bolts. Any spring which may be present in the metal is taken up by the elasticity of the cork, so that tight joints are insured not only during bench tests, but in actual service as well.

If boiling water or steam is kept in contact with the flat face of a cork gasket for any length of time, damage results. Where these gaskets are used between metal surfaces under pressure, however, they will withstand the temperature of boiling water or slightly higher. This is proved by the successful use of cork gaskets between the top and bottom plates of assembled radiators on motor trucks, and also between pressed steel water outlet and inlet manifolds, baffle plates, and motor head stampings.

Some other applications of cork gaskets are recommended by prominent motor builders, as a result of their experience. On cover plates for timing gears, valve compartments, transmissions, oil pumps, crank case accessories, clutch and fly wheel hand-hole covers, carburetor intake manifolds, differential housings, and various other parts, cork gaskets have stood up most satisfactorily under all kinds of service tests. They are easily applied with a thin coating of shellac or waterproof cement, spread over one of the contact surfaces. Care should be taken against the use of too much cement since it

will squeeze through the bolt holes and cause the gasket to stick on both sides instead of one. Before the parts are assembled, the gasket should be weighted down until the shellac is thoroughly dried.



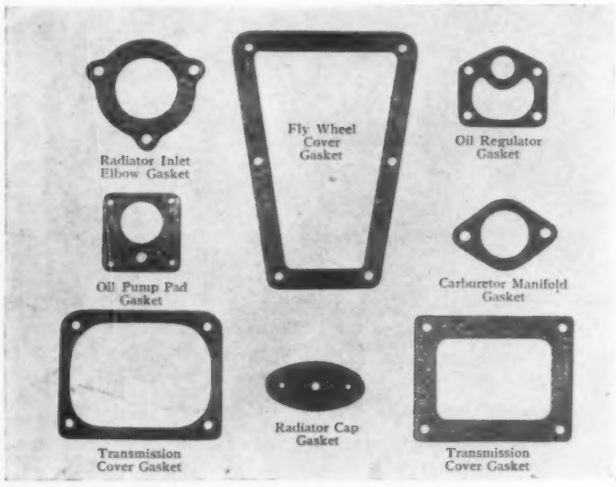
VALVE COVER GASKETS

Other Uses for Cork

There is a growing use of composition cork washers, which prevents rattling and the entrance of dust and dirt. They are also used in stuffing boxes where the speed of the shaft is not rapid enough to generate heat greater than that of boiling water. When used for purposes of this kind, cork washers not only keep dust and dirt outside, but prevent leakage of oil and grease.

Cork gaskets are also being used to prevent fan belts from slipping. It is needless to mention the undesirable action of a belt which slips on a fan pulley and allows the motor to become heated. If the pulley rim is covered with cork the fan will be driven at full speed, all the time, without slippage.

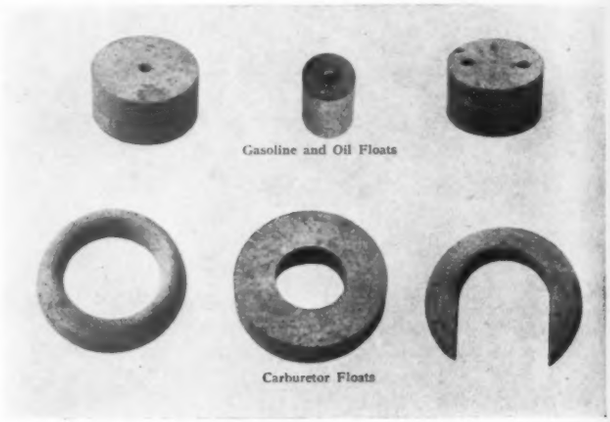
Besides being used for gaskets, cork is manufactured into



MISCELLANEOUS GASKETS

floats for carburetors, oil gauges and gasoline gauges. These are most always made of natural cork rather than of a composition, but their manufacture is necessarily varied because of the individual specifications to be followed. To give the best results, these floats should be heavily coated with shellac and thoroughly dried before being used. Natural cork is often utilized for clutch inserts, plugs for wire conduits and spark plug holes, etc. Strips of natural cork or of cork composition are often used as a cushion in body joints, and it seems reasonable to believe that this use could be profitably promoted in the construction of airplanes.

While it has not yet been adopted commercially, composition cork has proved satisfactory in all kinds of shop tests as a material for clutch facings, because of its unusually high



NATURAL CORK FLOATS

coefficient of friction. Cork has showed itself to be superior to leather under the trying conditions of clutch use.

All of the uses of cork have not been described here by any means, but a fair idea has been given of the functions which it performs in motors. For the benefit of those who may not be familiar with cork as a natural product, it may be said in conclusion that it is the outer bark of the cork oak tree, which flourishes in Spain, Portugal, and other Mediterranean countries. This bark is the most valuable part of the tree and is removed every eight or ten years. The tree begins to produce its best bark at the age of forty years. In stripping it, great skill is required to prevent injury to the inner skin, for such injury might kill the tree. Cork bark varies from one-half to two inches in thickness. One tree yields from 25 to 200 pounds at a stripping.

Aeronautical Patents

ISSUED MARCH 5, 1918

1,258,279—To Frederick J. Veitch, New York. Airplane.

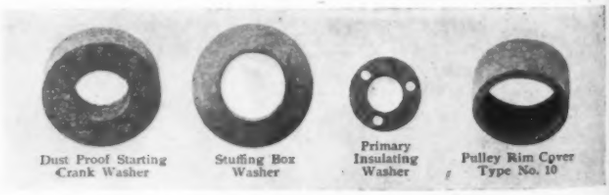
1,258,356—To Albert W. Myers and Robert R. FitzGerald, Ottawa, Ont., Canada, assignors to Albert W. Myers, Ottawa, Ont., Canada. Aerial Machine.

MARCH 12, 1918

1,258,743—To Richard Burchill, Tampa, Fla. Trench destroyer and army destroyer.

1,258,943—To Edmund Hugh Pryce, New York, N. Y. Flying machine.

1,259,083—To Isaac Covino, West New York, N. J. Airplane.



WASHERS AND PULLEY RIM COVER

ISSUED MARCH 19, 1918

1,259,578—To Mitro Wozny, Cleveland, Ohio. Balloon-vehicle.

1,259,804—To Francis A. Thornton, Richmond Heights, Mo. Aerial Machine.

ISSUED MARCH 26, 1918

1,260,474—To Frank Stevens, New York, N. Y., assignor of one-half to Julia Stevens, Niagara Falls, N. Y. Parachute case or envelope.

1,260,917—To Franklin William Lake, Kingston, Ontario, Canada. Airplane.

1,260,957—To Reuben B. Benjamin, Chicago, Ill., assignor to Benjamin Sellar Mfg. Co., Chicago, a corporation of Illinois. Aerial top.

The Use of Jigs in Airplane Manufacture*

By R. Borlase Matthews, Wh. Ex., A.M.I.C.E., M.I.E.E., F.AE.S.

A new industry calls for new methods—*autres jours, autres mœurs*—and the airplane industry is therefore not exceptional in demanding many departures from recognized woodworking practice. In the first place the number of machines required today is so large that their construction should be described as a manufacturing rather than a building operation. That is to say, they should preferably be almost entirely put together by the aid of accurate machinery instead of being dependent to such an extent upon the skill of the individual workman, in trying and fitting one part to another until the whole is built up. In this connection it may be remarked that the design of the metal fittings for airplanes is not such as to call for any radical departure from previous high class small metal working practice. It is the woodworking side of the business which presents the new scope for initiative. It is this latter aspect, therefore, which will be considered here.

The underlying ideal of the modernized system now advocated is that the arrangement of the work and the facilities for economically carrying it out should be planned and designed in the office as distinct from the shops where the actual work is done. For a great number of years it has been realized in engineering establishments that drawings are essential and economical, likewise sooner or later it will be appreciated that drawings of jigs and fixtures are just as necessary.

It may be mentioned in passing, that since the subject is treated as a whole, all the points raised, would obviously not necessarily be applied to the manufacture of one particular type of machine, as so much depends upon circumstances, the size of the order, the probabilities of modifications in design during progress, etc.

Definition of Jigs and Fixtures

The distinction between a jig and a fixture is not an easy one to define, as it is difficult to say where one ends and the other begins. A jig is a device which either holds, or is held on to the work, and at the same time incorporates guides for the various cutting tools; whereas a fixture holds the work while the cutting tools are in operation, but does not contain any special arrangements for guiding the cutting tools. In other words, a fixture is usually a device which must be entirely held or fixed to the machine on which the operation is performed. The term fixture is often, however, also applied to assembling arrangements of larger size, which form complete units in themselves and are generally permanently attached to concrete foundations. Gages must, of course, not be confounded with jigs.

A Comparison Between Engine and Airplane Manufacture

In manufacturing engines in quantities it has long been the practice to use jigs and fixtures in order to speed up production and also to ensure correctness of output. But up to the present, in airplane manufacture, this practice has not been adopted to such an extent as it might have been, with the result that it takes very much longer to turn out an airplane than is necessary. This delay arises, both in production of detail parts and also in the assembly of units and complete machines. Considerable time is lost throughout, in trying and fitting the parts into their correct relation, owing to errors in making the details.

For example, assume that in an engine two parts are required to be bolted together. These parts are not clamped together and then drilled both at the same time, nor is one part drilled and the other clamped up to it and drilled through the first. Both parts are drilled separately in jigs. This may be done in a separate department, or even in a separate factory, and still the parts will bolt together in their correct relation.

But in the majority of airplane works quite a different state of affairs exists. Take, for example, the case of spars which have to have metal brackets attached to clamp up to other parts. Here the metal parts are placed over the spars when they have been put in position relative to other parts. The spar is then drilled through holes already drilled in the metal parts. This entails much difficulty, because the job is inaccessible; it also promotes inaccuracy, owing to the operator having to drill from both sides to ensure that there will be a clear way for the bolts through both sides. All this troublesome work and subsequent delay would be avoided were the spars and metal parts drilled in jigs. All that would then be necessary would be to push the bolts and tighten up.

Again, take the spindling of spars. For the sake of comparison, the milling of straight metal parts may be considered, when the work travels on a horizontal table against the cutter. Here the length to be machined is controlled by stops. In the spindling of spars the job should be placed in a jig having stops upon it, so that it is impossible for the cutter to operate except where it is so desired. By proper design of the jig, the cut out portions will come in correct relation to the overall length and depth.

In cutting form or taper shapes, as, for example, the nose pieces on rotary engines, forming plates are used to compel the tool and the work to move in such a manner that the desired finished form is arrived at. This principle might well be adopted in woodworking, when parts have to be spindled to some special form or taper. The jig would be made with a "former" for bearing against the spindle, which will only allow the cutter to operate in such a way as to produce the desired shape.

The "former" idea should be extended to cover work on the band saw, either for roughing to shape or for finished work when the saw finish is good enough.

For the use of such "forming" jigs on spindling machines, the "former" should bear against a ball bearing embracing the spindle. This will very much reduce the wear on the "former" and so ensure a much longer life for the jig as regards accuracy.

Of course, these "formers" entirely do away with the necessity for marking out shapes, entailing, as the latter operation does, a great amount of time.

The various units that go to make up a complete machine should be assembled in a jig. The jig should hold each unit by at least two locating points. The units, when held in the jig, will all come into their correct relative positions. All that will then have to be done will be to bolt up, through holes drilled in the jigs used for making the parts.

Careful consideration as to the cost of production must be given before setting about the design of a jig or fixture, as obviously it is absurd if the cost of the jig is in excess of the anticipated gain. The only exception that would permit of the employment of a jig, which did not comply with the above conditions, is where accuracy of parts is of such importance as to make interchangeability of these parts absolutely essential.

Time and Cost Saved by Use of Jigs

As an illustration of time saving, many airplanes could be made in three-fifths of the present time required, if proper jigs and fixtures were in existence. The cost would be reduced by something like 25 per cent, this estimate being based upon a small number of machines, say 250. On a larger number, say 1000, the saving in labor would be about 50 per cent, and naturally the saving in labor means increased speed in production.

As a detail example of economy the elevator of a certain machine used to cost in labor alone £2 10s. 0d.; this was immediately reduced to under a sovereign on the introduction of proper jigs. Many other similar cases could be cited.

Jig and Fixture Drawings

A modern airplane requires at least 1200 jigs and fixtures. It is obvious that to make so large a number with accuracy, and to ensure that the right number are ordered, these jigs should be made to drawings. At present the comparatively few jigs that are employed are, as a rule, made to the shop foreman's more or less crude ideas. It therefore follows, that when some machine or parts of machines are made by more than one sub-contractor, there will, assuming all sub-contractors work to jigs, be as many different types or styles of jigs to do the same job. Each of these different jigs, to do the same job, is the result of separate thought.

Here, obviously, is an opportunity for economizing time,

*A paper read before the Aeronautical Society of Great Britain.

for if the jig had been properly designed in a drawing office, all that would have been necessary would have been to have sent a copy of the jig drawing to all sub-contractors, who would then have made their jigs without wasting time in thought and consideration.

The Need of Organized Design

In accordance with well tried principles, sometimes known in the aggregate as Taylorism (out of compliment to the original investigator), it is clear that if work is to be carried out according to scientific laws, the management must be so organized as to execute itself much of the planning formerly left to the initiative of the individual workman. The older method of works management has been described as that of "initiative and incentive," the underlying philosophy of which necessarily leaves the detail solution of daily problems to the man at the bench. The incentive offered in this way, in return for initiative, is merely monetary reward. The method is faulty, because the workman's whole time should be actually taken in doing work with his hands. Even if he had the necessary education and habits of generalization in his thought, he lacks the time and the opportunity for the development of the underlying scientific principles, and without these much effort can be frittered away. Again, any actual development of applications by an individual worker is not easily disseminated amongst others. Under scientific management exact scientific knowledge and methods must earlier or later replace rule-of-thumb ways everywhere. It may be fairly stated that the days have passed when an individual man of strong personality can do big things without the assistance of others. Rather, the present age is one of cooperative specialization, in which all great achievements are accomplished, and will continue to be, by that type of cooperation in which each man performs the function for which he is best suited, preserving fully his own individuality, and losing none of his originality and proper personal initiative. At the same time, however, he must be controlled by and must work harmoniously with his fellow men.

The Application of Organized Design

The application of scientific principles is naturally just as important in airplane manufacture as in any other branch of industry. It has its own special difficulties, but that is all the more reason that steps should be taken to effectively combat them. One of the strongest arguments brought forward against the adoption of a well developed jigging system for airplane construction, is that in the present stage of the art, developments are so rapid and so many modifications have to be introduced in the machines that it is impossible to evolve a reasonable system of manufacture. The reply to this is, of course, that the design details of the jigging system must be so elastic as to permit of the introduction of modifications without delaying the progress of work. This only means that all the greater forethought and intelligence must be exercised, and further emphasizes the fact that airplane designs must be prepared by practical specialists. From the foregoing remarks it will be gathered that airplane jig designs cannot always be as simple as might be desired, since the jigs must be so constructed as to be readily and quickly altered, with a minimum expenditure of time and material, to conform to any required modifications. After all, the general run of modification only affects minor details as a rule, hence the modification bugbear is not so serious a matter as it might appear to be at the first encounter, especially as only too many alterations are merely made to facilitate manufacture.

The existence of a jig and fixture drawing office would constitute a most valuable check upon the drawings, and would prevent many of the mistakes which have gone through to the shops in the past. This, in itself, would almost be worth the small extra staff and expense.

It has been estimated that during the life of many airplanes something like 400 modifications have to be incorporated, most of which are to correct drawing office errors and to overcome manufacturing troubles. A very considerable portion of these would be eliminated if jigs and fixtures were designed concurrently with the working drawings of the machines. As regards the elimination of manufacturing difficulties, it might be mentioned that one particular airplane could be manufactured in one-third the time it now takes if only the mechanical details were more united to manufacturing processes.

The obvious moral of the foregoing is that jigs and fixtures should be designed by a drawing office fully conversant with the whole design of the machine, including engine fittings and the fitting of the various instruments. To post all the shops and sub-contractors with this mass of information would obviously take a tremendous lot of time. Therefore it is clear that all the jigs for a machine should be designed by one drawing office and drawings and instructions distributed to the various shops and sub-contractors.

This centralizing of jig design has the great advantage, besides time saved in actual design, that all manufacturers will be posted as to the best way to make machines, having due regard to speed of production and soundness of job.

Another strong reason for a jig designing department is that the smaller airplane manufacturers, as a whole, are not mechanical engineers, and have had no experience upon which to fall back in designing jigs. In fact, many of them fail to appreciate that any speeding up of output could be attained by the extended use of jigs. This is due to the fact that in their experience, previous work of a different nature, they did not feel the need of such aids, as their work was more varied.

Classification of Jigs and Fixtures

It has already been mentioned that at least 1200 jigs and fixtures are necessary for the manufacture of a modern airplane. In fact (including jigs for metal fittings) one maker employs 5000 to great advantage. Hence, it will be of interest to consider the classification of a modern equipment.

1—Parts Jigs

(*a*) *Mill Jigs.*—For sawing, spindling, etc., parts to their exact size.

(*b*) *Drilling Jigs.*—For drilling all the holes called for on the fittings, the necessary bolt holes and the entering holes for large wood screws.

(*c*) *Parts Jigs.*—For completing the small built up parts, ready for attachment to components.

2—Component Jigs

(*a*) *Building Jigs.*—For assembling the various parts into a component (such as ribs, ammunition carriers, etc.).

(*b*) *Taping and Varnishing Jigs.*—For assisting in the quick winding of tape where necessary and for presenting the component in the best possible way for doping and varnishing. These jigs usually take the form of two center points on which the work rotates.

3—Unit Jigs and Fixtures

(*a*) *Unit Assembling Jigs.*—For assembling parts and components into a unit (such as wings, bodies, ailerons, tail planes, etc.). These should locate the exact position for each part; and the parts, if made correctly, need not be touched by hand, the only work necessary being the insertion of necessary bolts, screws, etc., and wiring.

(*b*) *Unit Fixtures.*—Take the form of benches specially made for a certain process, such as covering with fabric, doping, etc., designed to facilitate rapid handling of the unit in construction.

4—Erection Fixtures

Are constructed to facilitate assembly of the units to the complete machine. A cradle should take the body in its correct position, giving access for affixing the undercarriage, the tail skid, and the planes. A supplementary fixture gives the exact position of the wings at the tips and body, and obviates the difficulty of correctly pitching the dihedral, using plumb lines, etc. A tension gage or tautometer should be used to determine the tautness of wiring, and by careful application a much better rigging will be ensured than is secured by the old method of straining until the correct alignment is secured.

The Principles of Design of Jigs and Fixtures

The general principles that must be followed out in laying out a jig or fixture is to decide upon the locating points of the outline of the clamping or holding arrangements. It should be borne in mind that these latter devices must be as quick acting as possible, and for rough work (*i. e.*, the early operations) some of the locating points will have to be made adjustable. Each jig should be so arranged that the work can only be inserted in the correct way. The ideal method of arranging the clamping and fixing devices is by placing them in

the best position to resist the pressure of the cutting tools, that is, all clamps and fixing devices should be integral parts. At the same time complication must be avoided, as one of the objects of a good jig is to eliminate highly skilled labor. Effective support must be provided opposite to surfaces that contain guide bushings. If possible, the jig should be so designed that all the locating points are visible to the operator when placing the work in position. Suitable clearance must be provided for the escape of cuttings and chips. Auxiliary devices that facilitate the manipulation of the jig, such as handles, should be provided whenever they assist in shortening the time required.

Many works claim to have very good jig equipments. Unfortunately, however, when the matter is probed into by any one who really knows the full application of this method of manufacture, the reverse is only too often found to be the case. The usual much-lauded jig equipment generally only comprises a comparatively small number (*i. e.*, in regard to the 1200 or so previously mentioned as necessary) of so-called board jigs. These consist of flat boards fitted with positioning stops and cam clamps. There is perhaps no more simple and useful all-round type of jig than this, and it is very widely used in many most ingenious modifications. Unfortunately, however, it is often incorrectly employed, being used as a gaging jig rather than an assembling device. That is to say, a carpenter's bench is placed alongside, and strips of ready planed wood are tried out to length and fitted in place by the handicraft of the workman. In good modern jig practice, hand tools are entirely prohibited. The reason for this is that all parts, however small, should be made in their own particular jigs. If at any time it is discovered that a part does not fit correctly into its proper place, hand tools must not be used to correct the deficiency, but rather the fault which caused the defect must be eliminated from the worn or incorrect jig originally used to make that part.

A description of the whole art of the design of jigs and fixtures would require a voluminous treatise. As neither space nor time will permit of such full treatment here, it is proposed to summarize in the form of a running commentary a few of the main points that are often overlooked.

Saw Mill Jigs

A great deal of subsequent work can be saved if the preliminary rough sawing is done to close limits of the finished sizes. This can be accomplished by means of suitable jigs, which can be clamped on to the timber and serve as guides. During sawing, the guiding portions would be kept by the sawyer in contact with fences on the saw bench.

Spindling Machines

With the aid of carefully thought out jigs these machines are invaluable to an airplane manufacturer. At the present time they are not utilized to anything like the extent to which they should be for lack of jigs. Preferably suitable ball races should be fixed on the projecting portions of the spindles for the jigs to bear against and thus reduce jig wear to a minimum. As far as is feasible safety tool holders should be employed, for not only are they a protection to the operator, but they also facilitate the setting of the tool and the cutting edge is more easily arranged at the best cutting angle.

No hand tool work should be permitted in an airplane factory. Hence, all parts, even the smallest, should be made on spindling machines of some kind. With the aid of proper jigs it is really wonderful what work can be done in this direction. For light work it is not essential to employ the heavy standard spindling machines, as some manufacturers have successfully employed short ball-bearing shafts, which have been fixed in a vertical position on stout wood framework.

Jigs for small parts should be so constructed that several pieces may be spindled at the same time; if the clamping arrangements are adequate, the several pieces will lie flat and the finished shapes will be identical.

Color Scheme

These various small pieces should be stored in separate boxes or bins. All the boxes or bins containing the pieces for one particular component should be painted a distinctive color or combination of colors. The jig in which these parts are assembled should be painted the same color or combination of colors. This materially assists the operatives, and is a scheme which might be standardized throughout the country.

Tools and Gages

All special form cutters should be made to designs prepared in the jig and fixture drawing office. This will ensure all sub-contractors turning out identical parts. The tools should be set in the various machines to gages and not to pattern parts. These gages should be designed in the drawing office. Then all sub-contractors would have to set their tools to perform exactly the same work, and incidentally save considerable time.

All cutters and gages should be made in quantities in a tool-room, similar to an engineering works tool-room. An operator should not be allowed to do anything to a tool more than just to stone it up in position. The tools should be set in the spindle to a gage and not to a pattern part. By this means any number of sub-contractors will be in a better position to produce identical parts.

All tools and gages should be made to special drawings and not according to the operator's ideas in the various shops. Thus, a complete record is kept of how to do a job, and it is an easy thing to start a new workman in the way he should go.

If proper use is made of jigs, tools and gages, it will be impossible to turn out work that is not correct, although the worker may have no experience of airplane work at all.

Special Tool Steels

It is put forward that undoubtedly superior steels should be employed for wood working than those now utilized. This would permit of the machine tools operating at higher speeds than they do at present, which would result both in a bigger output and better work. Machines which now run at 5000 r.p.m. could be speeded up to something like 7000 r.p.m. It is true that this would shorten the life of each machine, but much better and quicker work would be done.

Special Shop to Make Jigs, Tools and Gages

It is suggested that since most airplane sub-contractors have no tool-room facilities, a special jig and tool shop should be run in connection with the drawing office to manufacture all tools, jigs, etc., which sub-contractors are not in a position to make for themselves. Then tools and gages could be turned out in quantities and sub-contractors would be assured of a good supply to assist them in their efforts to attain maximum production.

Much could certainly be learned from metal milling practice that could advantageously be applied to the operation of spindling machines. In fact, inverted spindle machines with face cutters are already in use. Horizontal spindles could also undoubtedly be employed with advantage.

Drilling Jigs

Much greater accuracy could be secured by making the guide bushes for the drills of proper length, relative to the size of the drill. At present many drilling jigs do little more than serve to indicate the position of the holes—there is insufficient bearing to take care of the truth of the drilling.

Limits

As in the case of metal working, absolute accuracy in woodworking is not only impossible, but also unnecessary. Hence, maximum and minimum limits are required for all dimensions in airplane work. These limits are naturally much wider than those essential for metal work. For bolt holes they are usually of the order of plus or minus 0.01 in. For lengths of under three feet the allowance is normally plus or minus 0.03 in.; for longer pieces the allowance is increased 0.01 per foot; due discretion being exercised according to the circumstances; for instance, on aileron hinge joints of, say, eight feet or so, it would not be more than 0.04 to 0.05 in., with present-day designs. However, hinge design is a matter that should receive more attention. There is a tendency for spars to warp across the grain if exposed to bad weather conditions, hence a limit of 0.05 in. is usually provided to counteract these atmospheric effects.

When seasoned wood has been milled it should be laid aside for about ten days and then drilled by jig before the fittings are assembled. It will then be found that no trouble will be experienced when the parts are fitted together, as there will be no appreciable shrinkage under these conditions.

Board Jigs

Small pieces are generally put together to form components on a board jig. This consists of a board on which small posi-

tioned pieces of wood (or in some cases metal) and locking turn buttons are fixed in such a way that a piece of wood placed round the outside or inside will assume the required curve. If these boards were built up on some sort of box frame, or series of small boxes, and the ordinate length stops fixed to sliding pieces, these boards could be turned out in quantities and merely adjusted to the various ribs. This would save considerable time in setting up the board, and when a particular rib was finished the board would not be scrap, but could be readjusted to fresh parts.

In the case of board jigs for holding pieces together when glued, the curve must be cut from a board so as to give contact along the whole outside member. Clamping cams, or turn buttons, for board jigs, should be standardized and turned out in quantities so that they can be supplied from stock. These cams should be designed so that they will give a grip that is not too sudden. One of the best designs is that of an eccentric "comma."

Unit Assembly Jigs

The wings, tail planes, etc., should be fitted together in a jig, so designed, that both sides can be worked on and in such a way that it is impossible to assemble a portion in the wrong manner. For glueing operations a number of similar jigs are often required, so that sufficient time may be allowed for the glue to set without holding up the workpeople. Glued portions should be clamped together until set. On large assembly jigs the design of suitable clamping devices affords exercise for much ingenuity.

A matter that is often overlooked in airplane erection is the necessity for cramping together, under considerable pressure, all members which have been cut across the grain in the process of manufacture. The reason for this is, that however well set the saw may be, it always leaves a soft, fibrous mass at the end of a piece of wood when cross-cutting it. Heavy pressure will bed the ends of sawn members together. In the case of airplanes, which are assembled without proper cramping arrangements, it is found that all the tie wires become slack after one or two landings. This is undoubtedly due to the giving of the unbedded ends of the various members.

Jigs should be so designed, as a rule, that no operation on them will require more than, say, two hours's work at a time. Such an arrangement greatly facilitates the passage of work through the shops.

A fixture is in use in several works in which the wings are placed with the correct incidence and dihedral angles. The wires are then strained so that the leading edge assumes such a position relative to a fixed point on the jig that the wing takes up its correct form. The wings are then sent for covering and doping, and it is found that they very seldom require any adjustment when fitting to fuselage. This, of course, means that wings can be made in quantities and stored, to be withdrawn as required, whether as spares or for fitting to new machines. Some such jigs should be used in the final erection of wings on a machine to ensure that they take up their correct position. To speed up the work, a tautness meter may well be used for rapidly testing the straining of the wires.

In one type of fixture, the rear portion of the body is fixed on a sliding table, to have the rudder post fitted dead square and central. There are also guides, so that the four front ends of the longerons may be cut off square relatively to the rudder post and to the correct length. The rear portion is then a complete unit, ready to be fixed to the rest of the machine without any further fitting. This is a most desirable fixture and should be used whenever applicable. In the case of large machines, the sliding tables should be on the floor level so as to make the job easily accessible.

Erection Fixtures

The whole machine (not necessarily always including the wings and undercarriage) should be finally erected in a specially constructed fixture. This usually consists of a large surface plate or a concrete foundation, with brackets fixed so that the various units must come into their correct relative positions. Less reliable forms consist of timber structures.

Conclusion

There seems to be no doubt but that for even the building of a small number of airplanes considerable use should be made of both part and component jigs. If the number is in the neighborhood of 50 or so, the utilization of quite a number of unit jigs will be advisable, while for anything over 250 machines, jigging can be carried to a considerable extent with great advantage, including more or less elaborate erection fixtures. In fact, the only risk in thorough jigging may be said to be in the case of erection fixtures, owing to changes in airplane design. However, even these appliances can be designed upon an adjustable basis.

Reference has been made earlier in this paper to the need of organized design along modern scientific lines. Such methods benefit the worker in enabling him to earn higher wages with less strain, while at the same time it is advantageous to the employer. In this consideration a third great party had been overlooked—the whole nation—the consumers, who purchase the product of the first two, and who ultimately pay both the wages of the workpeople and the profit of the employers. A brief scrutiny of industrial history indicates that finally the whole nation gets the greater portion of the benefit coming from industrial improvement. To this end, therefore, any progress in the development and application that may be made in this connection must be to the ultimate benefit of the people as a whole—even if it appear to be but a side line in industrial work. At the present moment economy in man power is of all importance, therefore anything which can accelerate the output of such important war material as airplanes should be given very careful consideration, even if it involves such a disturbing effort as the direction of thought along unaccustomed lines.

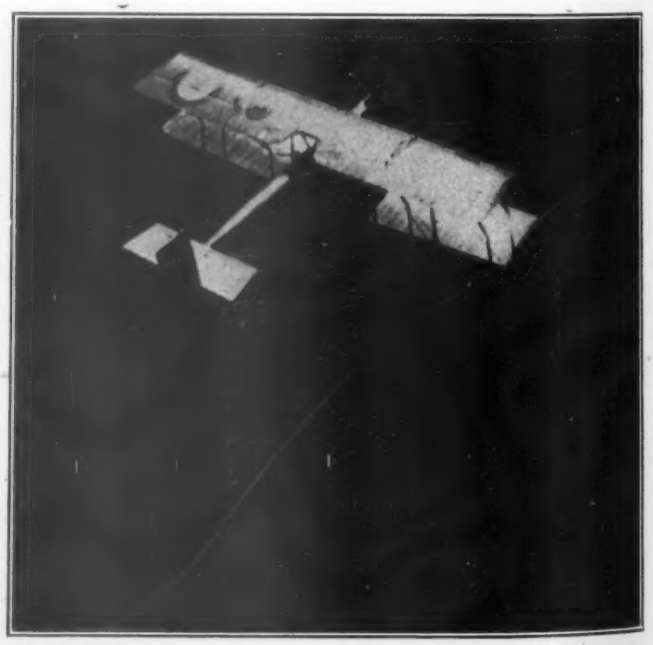
Such then is the case for the more extended application of the use of jigs and fixtures in the manufacture of airplanes.

Screw Thread Standardization

A bill providing for a commission composed of five members to be known as the Commission for the Standardization of Screw Threads has been introduced in Congress by Representative Tilson. The chairman, under the provisions of the bill, will be the director of the Bureau of Standards. One member will be a commissioned officer of the Army; one a commissioned officer of the Navy, chosen by the secretaries, and two will be appointed by the Secretary of Commerce, one of whom shall be chosen from nominations made by the American Society of Mechanical Engineers, and one from nominations made by the Society of Automotive Engineers.

The standards recommended, when accepted and approved, will be used in the several manufacturing plants under the control of the War and Navy Departments, and, so far as practicable, in all specifications for screw threads in all manufactured articles.

The necessity for such legislation in connection with war work has been apparent for some time, and the bill provides a way of bringing about uniformity in the standards for screw threads, especially in the matter of tolerances.



FRENCH A. R. (DORAND) RECONNAISSANCE BIPLANE
(C) *Kadel and Herbert*

The Model C.V Albatros Biplane—Continued

The Tail Plane Attachment

Reference has already been made to the peculiar attachment of the tail plane to the body, which is shown in perspective in Fig. 15. The bulkheads of the body are extended outwards to form cantilever beams which support the tail plane. There are three of these cantilever beams, while further support is provided for the tail plane leading and trailing edges as indicated in the sketches. The spars of the tail plane are of the box type, built up of ash flanges with thin three-ply sides and cut out for lightness. These spars are so proportioned that they fit over the cantilever beams, which do not, it will be seen, run right out to the edge of the tail plane, but are finished off just outside the second tail plane rib. No external bracing of the tail plane is provided, the depth of it and the method of mounting being relied on for the necessary strength.

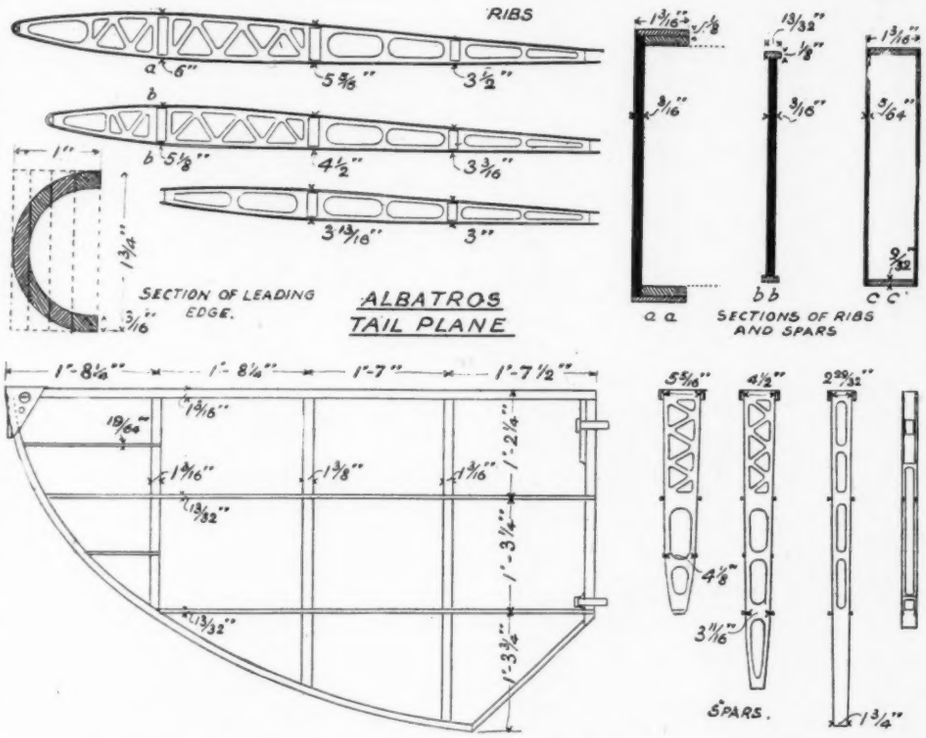


FIG. 13. DETAILS AND DIMENSIONS OF THE MEMBERS OF THE TAIL PLANE

To provide against the tail plane sliding off its cantilever supports, it is secured at the leading and trailing edge. The former attachment is indicated in the bottom right-hand corner of Fig. 15. A sheet steel shoe fits over the corner of the leading edge and inner rib, and through this shoe a long bolt passes, which runs across the body to a similar shoe on the other side. In Fig. 16 is shown the rear attachment of the tail plane. A sheet steel box surrounds the corner of the body. Welded to this box is a short tube which fits into a circular recess in the end of the trailing edge of the tail plane. As the elevator tube runs right across and is fitted with collars bearing against the sides of the clips that form the bearing for the elevator tube, the trailing edge of the tail plane is prevented from slipping outwards.

The manner employed of forming bearings for the elevator is indicated in the diagrams of Fig. 16. A steel strip is bent over the tube, and its two free ends are bent over and fit into slots in the trailing edge of the tail plane. Each clip is then secured to the tail plane by a vertical bolt. The trailing edge of the tail plane is spindled out to a semi-circular section, as shown, and a curved metal distance-piece is screwed to this trailing edge or spar, so as to form the second half of the bearing of which the bent steel strip forms the other half. To remove the elevator, the bolts securing the clips are undone; the clips are then bent outwards until their free ends clear the slots, when the elevator can be removed bodily.

As the elevator is built of steel tubing throughout, wood blocks of the shape shown in detail 1, Fig. 16, are employed for attaching the fabric covering. These blocks span over the steel strip bearings, and are secured to the tubular leading edge of the elevator by screws as shown in section B-B. A hole in the opposite wall of the tube serves for the insertion of the screwdriver.

Under the horizontal stern post of the body are two short tube stumps, closed at their lower ends. The object of these is not at first apparent, since they appear too short to protect the elevator; but when it is remembered that the Germans favor transportation by road, trailing the airplane behind a lorry, it becomes at once evident that these stumps serve to support the stern of the body on the floor of a lorry, while the machine is trailed behind on its own wheels.

As regards the remaining details of the tail of the Albatros little need be said, as they are fairly evident from the plan and sections of Fig. 13. It will suffice to point out a rather ingenious construction of the leading edge of the tail plane. In plan the tail plane is, roughly, semi-circular, and its leading edge, therefore, has to be shaped to this curvature. As an ordinary strip of solid spruce spindled out to a semi-circular section would scarcely be strong enough for this work, a different method has been employed. It appears that originally the leading edge of the tail is made up of four laminations of ash, having, of course, their grains running in slightly different directions. The rectangular section spar thus formed is then spindled out to a semi-circular section, as shown in the diagram, leaving the impression that the leading edge is made up of seven thin strips of wood glued together. The resulting leading edge appears to be one of great strength, while at the same time being quite light.

The cockpits of the Albatros are arranged in the fashion now universally adopted fro two-seaters by Allies as well as by the enemy, i. e., the pilot in the front and the gunner in the rear cockpit. The pilot's seat is mounted, in the Albatros, on the main gasoline tank, which has two annexes on top, one on each side of the seat. This arrangement is clearly indicated in Fig. 17, in which the small clips preventing the seat from sliding about on the tank will be noticed. The filler cap is mounted on a tubular projection extending through the body covering, thus enabling the tank to be refilled from the outside. A smaller auxiliary tank is mounted above and to the rear of the main tank, in the gunner's cockpit, as a matter of fact. Both tanks are connected up to a

FIG. 14. THREE-QUARTER REAR VIEW OF THE ALBATROS C.V

by-pass or distributor, so that both or either tank can be connected up to the engine, two pumps being provided for maintaining the necessary pressure, one driven by the engine and the other hand-operated. Thus, whatever tank is being used, gasoline is fed to the carbureter under pressure. This has

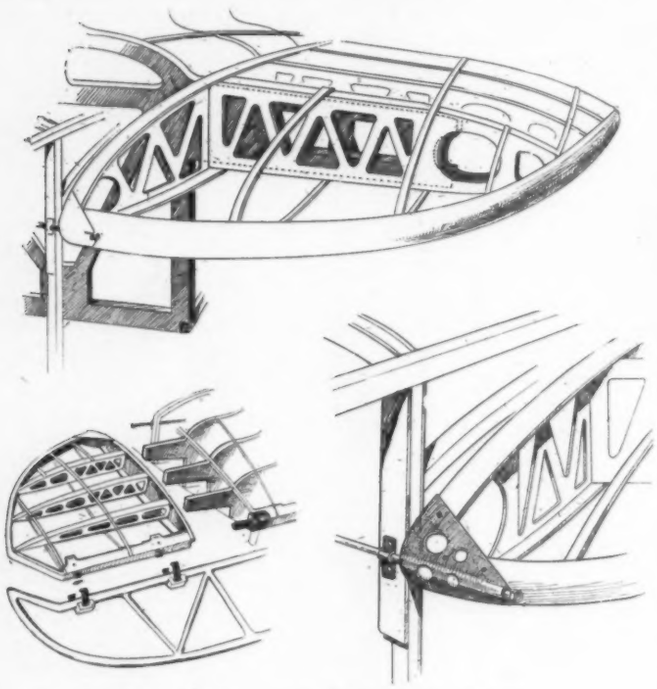


FIG. 15. DETAILS OF THE TAIL PLANE

probably been a necessary provision, as the tanks are placed relatively low and gravity feed would, therefore, be apt to be unreliable when the machine is climbing at a fairly steep angle.

Constructionally, the gasoline tanks are of interest in that

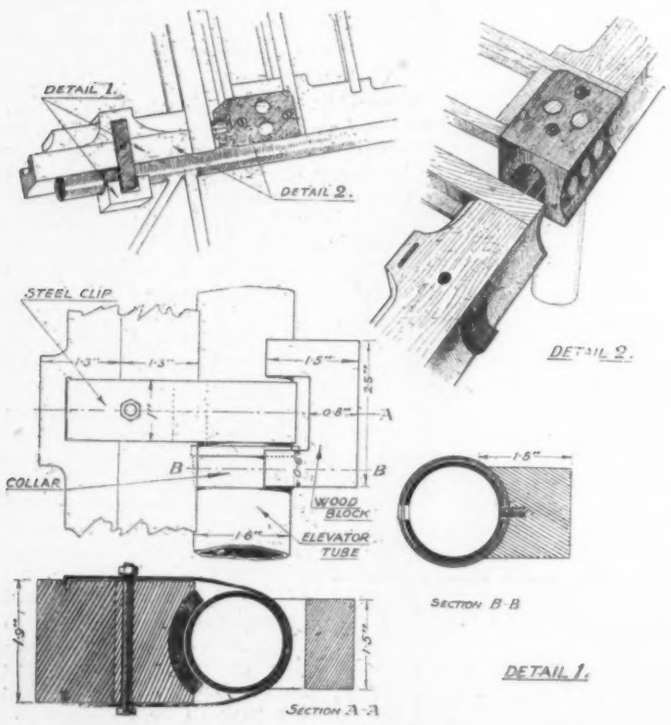


FIG. 16. DETAILS OF THE TAIL PLANE AND ELEVATOR ATTACHMENT

they have been internally braced by rods running across from side to side, the attachment of the rods being visible on the outside of the tank as shown in Fig. 17. To prevent the gasoline from slushing about inside when the tank is nearly empty, baffle plates are fitted dividing the main tank longitudinally into five compartments, communicating with each other through the circular openings shown in the section of the tank (Fig. 17). As the supply pipe leaves the tank fairly high up, it is carried down inside to the bottom of the tank so as to enable the last drop of gasoline to be forced out and into the carbureter. The main tank is mounted on brackets, and is secured by metal straps having an arrangement for adjustment.

In Fig. 18 is shown the general arrangement of the controls.

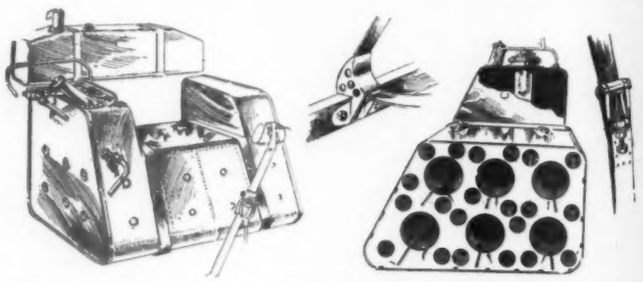


FIG. 17. THE MAIN GASOLINE TANK, SERVING AS THE PILOT'S SEAT

There is a transverse rocking shaft on which are mounted at each end crank levers for operating the elevators, while in the center pivoted, so as to be free to rock laterally, is mounted the main control lever. Mounted on the transverse shaft, but not moving with it, is another lever, which operates the claw brake mounted on the wheel axle. By pulling the lever the free end of the claw brake is pulled upward, thus causing the claw to dig into the ground. On releasing the lever, the brake is returned to its normal position by the action of the spring shown in the sketch.

The transverse rocking shaft is carried, as indicated in Fig. 14, in two bearings mounted on the lower longerons. A forward and backward movement of the control lever causes the shaft to oscillate, and with it the two crank levers, to which are attached the elevator control cables. These cables run from the crank lever around a pulley slightly forward of the

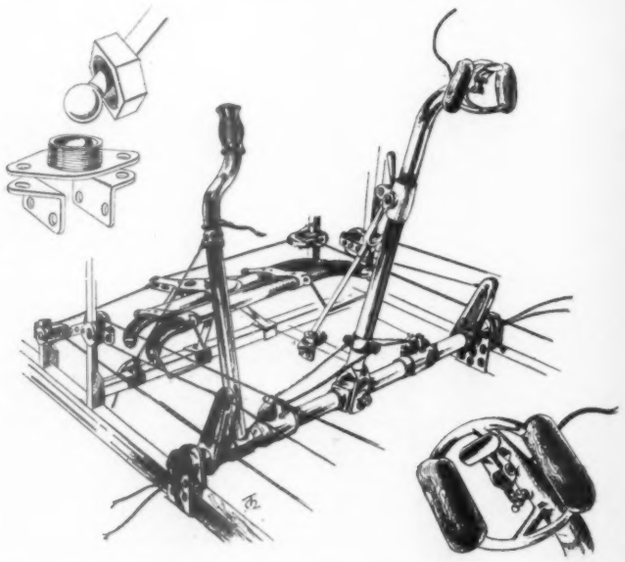


FIG. 18. THE CONTROLS. INSETS SHOW BALL AND SOCKET JOINT FOR THE CONTROL LEVER LOCK, AND THE HAND GRIP WITH GUN TRIGGER. THE LEVER ON THE LEFT OPERATES THE CLAW BRAKE

transverse shaft, as shown in the sketch, and hence to the top crank lever on the elevator. The return cable runs from the crank on the under side of the elevator to the crank on the transverse shaft. En route, these cables pass over pulleys mounted in the rear position of the body.

As regards lateral control, the general arrangement of this is indicated, in diagrammatic form, in Fig. 21. From the control lever the direct cable passes over a pulley on the transverse shaft, along through the bottom wing, around another pulley in the wing, and hence to the rear half of the aileron crank

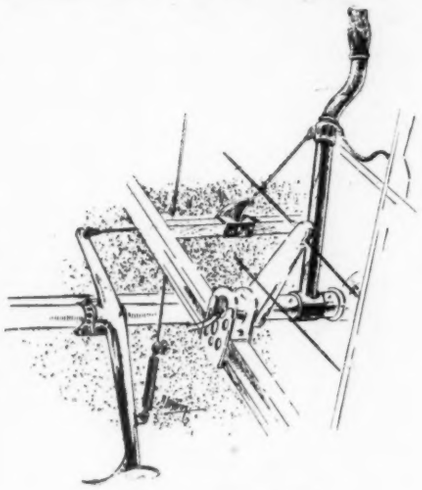


FIG. 19. THE CLAW BRAKE (DIAGRAM)

lever. The return cable runs from the front half of the aileron crank lever, around another pulley in the lower wing, through the wing and through the transverse shaft to a pulley on the other side of the control lever, and hence to the screw on the control lever. The details will be clear from Fig. 18.

The foot-bar operating the rudder is mounted on a pyramid of steel tubes, and the rudder cables are taken not from the foot-bar itself, as is generally done, but from a short lever projecting forward at right angles to the foot-bar. From this lever the cables pass over pulleys and to the cranks on the rudder. It will be seen that provision has been made for making adjustments of the foot-bar to suit pilots of different height by fitting an extra foot-bar. If the machine is to be flown by a taller pilot this is removed and the main foot-bar used. Wire clips are provided, it will be noticed, for accom-

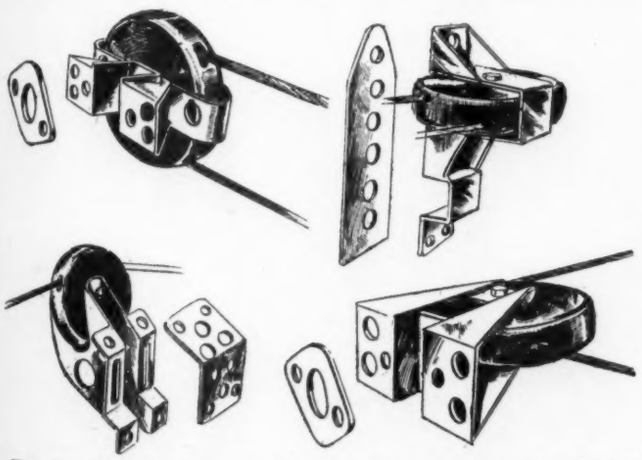


FIG. 20. THE PULLEYS AND BRACKETS OF THE CONTROL CABLES

modating the pilot's heels so as to prevent his feet from slipping off the foot-bar.

As in the majority of German machines, provision has been made for locking the control lever in any position, either flying level, climbing, or descending. This is accomplished by means of a collar free to slide along the control column, but being split and provided with a bolt for tightening up when the collar is locked in position on the control column. Anchored to this collar by two screws is a fork end, from which a tube runs down and forward to terminate in a ball and socket joint secured to the bottom of the body. This ball and socket joint enables the control column to be moved freely in any direction, and to allow it to be moved from side to side, even when the forward movement of the column is prevented by locking the collar. In this manner the pilot can lock the elevator, while operating the control column from side to side for lateral control with his knees.

As far as can be ascertained, although the machine gun was not in place on the machine as exhibited, one synchronized machine gun was fitted, resting on top of the body on the right-hand side. The pilot operated this gun by means of the trigger on the hand-grip of his control lever, which is shown inset in Fig. 18.

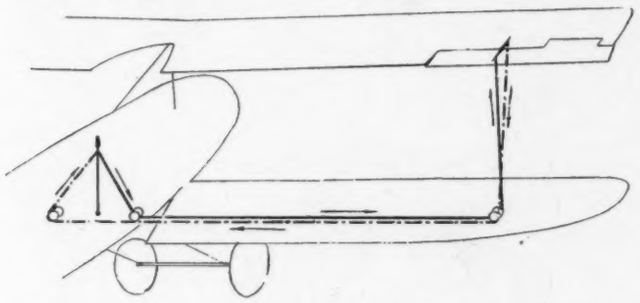


FIG. 21. DIAGRAM OF THE AILERON CONTROL SYSTEM

While on the subject of controls, reference might be made to the crank levers on the elevator and rudder. These are shown in Fig. 22, from which their construction will be evident. The crank lever of the elevator has projecting from it a tapering tube running to the trailing edge of the elevator. The tubular rudder post is working in bearings similar to those previously described when dealing with the hinges for the elevator. At the bottom the rudder tube fits into and is supported by a socket carried on a clip bolted to one of the transverse bulkheads of the body. A peculiarity characteristic of the Albatros is the method of attaching the control cables to the crank levers. A socket is formed in the end of the crank lever, and into this fits a cup-shaped piece of steel machined on one of the bolts of the wire strainers, much in the same manner as the terminal attachment of the main lift cables. Thus any vibration in the control cable is not transmitted to the crank lever, the cup-shaped head of the turnbuckle bolt being free to move in its socket in the crank lever.

Reference has already been made to one part of the armament of the Albatros, namely, the synchronized machine gun operated by the pilot from the trigger on the main control

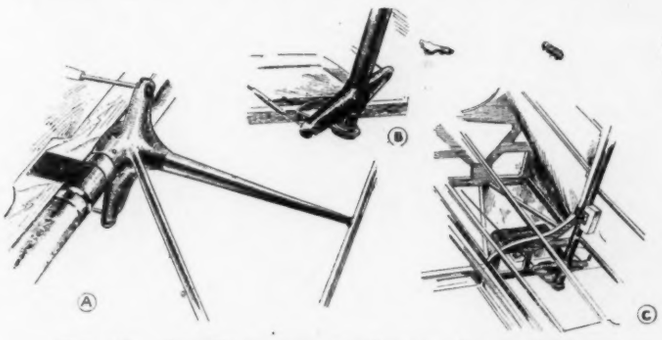


FIG. 22. THE ELEVATOR AND RUDDER CRANK LEVERS [(A) ELEVATOR, (B) AND (C) RUDDER]

column. In addition, there is a movable machine gun mounted on the usual gun ring in the rear cockpit (Fig. 23). The gun ring itself is built up of thin, three-ply wood, and runs on small rollers on its support so as to reduce friction. It is prevented from tilting up by wooden angle-pieces screwed to its underside and overlapping the fixed support. The whole arrangement looks somewhat clumsy, but is apparently quite light, and the strength is probably reasonably good, as the three-ply of which the gun ring is built is made up of different curvatures, each of which tends to strengthen the others.

The machine gun is supported on the gun ring by a swiveling fork, which can be raised and lowered as required, and which can be locked in any desired position by the locking arrangement indicated in the sketch of the general arrange-

ment. In addition to its circular movement integrally with the gun ring, the machine gun may be swung laterally on its pivot in the gun ring. Here also a locking device is provided in the shape of a split collar locked by an L-bolt, as shown in

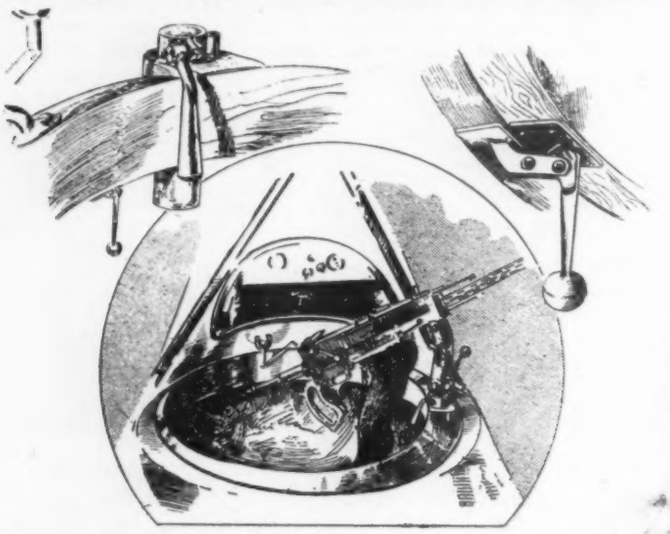


FIG. 23. THE MACHINE GUN MOUNTING ON THE AFTER SEAT

one of the insets. The other inset in Fig. 23 shows the lever by means of which the gun ring is locked in any desired position. A rocker arm composed of two steel strips is pivoted in its center on a pillar projecting downward from the gun ring. At one end this rocker arm carries a plate welded to the two steel strips of the rocker, and at the other it carries the hand lever, which is so formed and pivoted as to give an eccentric movement when the lever is swung through an arc. The *modus operandi* will be clear from the sketch. When the

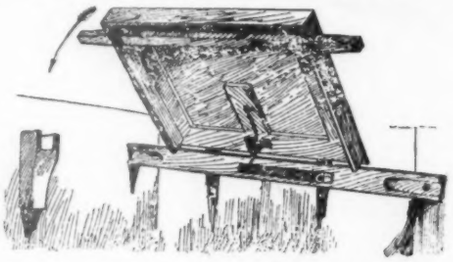


FIG. 24. THE HINGED SEAT OF THE AFTER COCKPIT

gun ring has been swung around to the desired position, the hand lever is pushed down; in so doing the eccentric forces the inner end of the rocker down, thus causing its outer end carrying the flat plate to move up against the fixed support for the gun ring, and thereby locking it. A pull on the lever instantly releases the gun ring if it is desired to swing the gun around to another quarter.

As presumably it frequently happens that the gunner wishes to fire from a standing position, his seat has been so arranged as to swing into a vertical position as soon as it is relieved of his weight. This is accomplished by means of a spring under the seat (Fig. 24). A strip of wood runs transversely under the seat and projects a short distance on either side. These projections rest, when the seat is in a horizontal position, in brackets secured to the sides of the body.

(To be continued)

An Early Helicopter

Sir Charles A. Parsons, whose name is prominently connected with the steam turbine, is also one of the pioneers of aeronautics. As far back as twenty-five years ago Mr. Parsons made a series of experiments with a small steam helicopter which raised itself about 12 ft. from the ground.

A description of this interesting forerunner of the vertical lift machine is given by Mr. Parsons in *Aeronautics* in the following terms:

In the summer of 1893 I made some experiments on the effect of steam-jacketing small steam-engine cylinders by placing the whole of the cylinder and valve-chest inside the boiler. The increase of economy was so marked that I was led to try whether a small toy engine could be made to sustain its own weight in the air by the lifting power of an airscrew on the crankshaft.

The boiler is of seamless steel, 2½ in. diameter, 14 in. long, and .01 in. to .015 in. in thickness; the steam cylinder, single acting, 1¼ in. diameter by 2 in. stroke, and about .03 in. thickness of tool steel; the piston is of thin cup form, also of tool steel; the admission valve is cylindrical, ⅛ in. diameter, cutting off at ¾ stroke. The whole of the valve and cylinder are within the boiler. Some parts of the engine were soft soldered and some hard soldered; the screw is of cane covered with silk. The working pressure was limited to about 50 lbs. per sq. in. The total weight of the apparatus, with water, is 1¼ lb.

Steam was raised by placing the boiler over a spirit-lamp, and when 50 lb. was registered on the gage, and the engine started, it raised itself in the air vertically to a height of several yards. The revolutions of the engine were about 1200 per min. and the i.h.p. ¼ hp.

The same engine was then mounted on a framework of cane, covered with silk, forming two wings of lift span, and a tail, the total area being about 22 sq. ft. The total weight was now 3½ lb., and when launched gently from the hand in an inclined horizontal direction it took a circular course, rising to a maximum height of about 20 ft. When the steam was exhausted it came down, having traversed a distance of about 100 yd.

Considering the primitive construction of the apparatus, the result clearly showed that flights of considerable distance, possibly some miles, were quite possible with small, economical steam engines mounted on airplanes. The boiler was also found to be able to steam the engine continuously by using methylated spirits instead of water in the boiler, and burning the exhaust as fuel; but when in flight the force of the wind extinguished the flame. It was clearly seen by the experiment that for practical, commercial success of this class of steam apparatus an air condenser is essential, as the weight of water used in a few minutes' run equals the total weight of engine and boiler. Without a condenser the length of flight must necessarily be limited to a very few miles, and it would seem that the chief problem that workers in this field have to solve is to obtain an efficient and light dry-air condenser.

In view of the presently reviving interest in the helicopter, the opinion of Mr. Parsons on this type of aircraft is of particular value. This early investigator of the problem says:

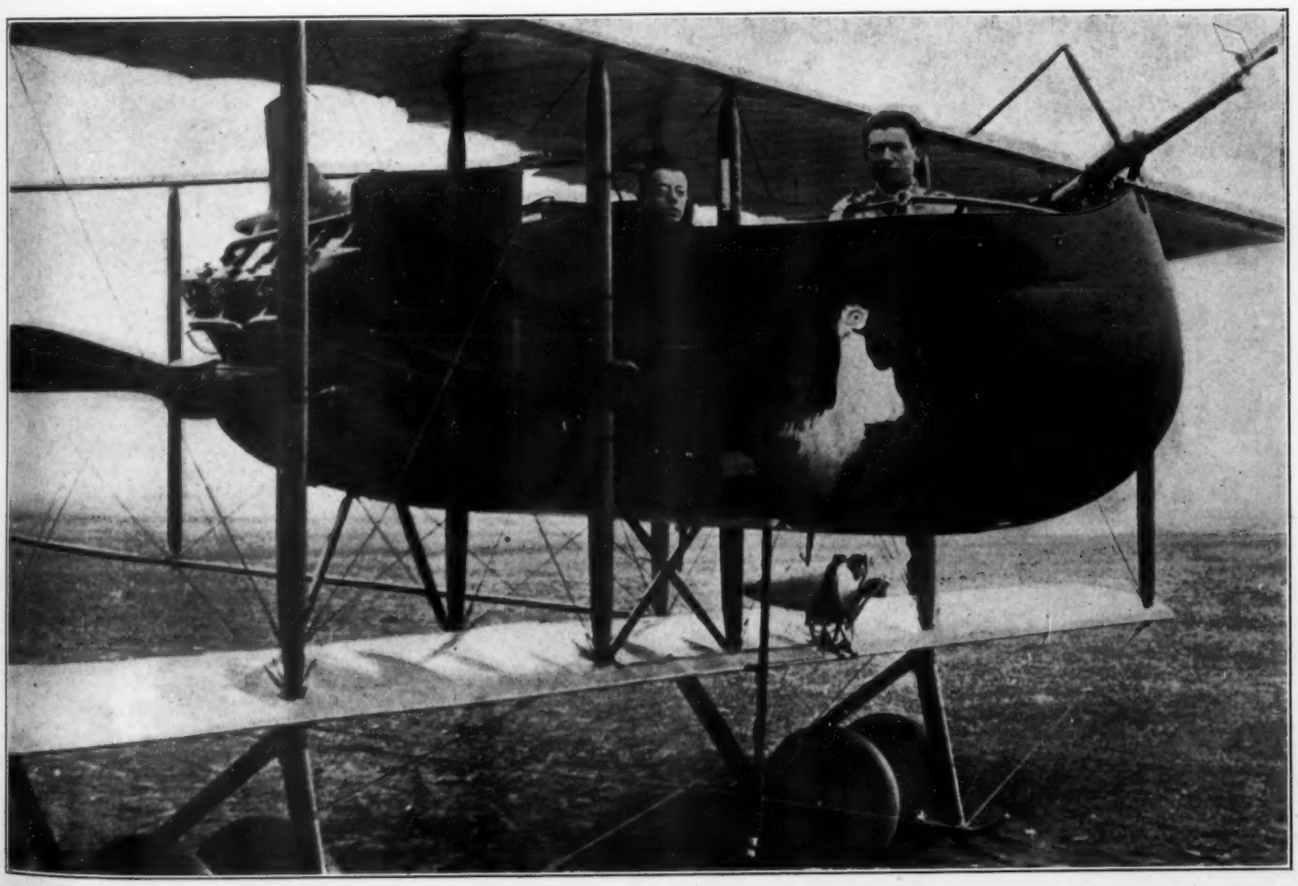
"The helicopter, which is a machine that will lift itself in the air without horizontal motion, has been the dream of many inventors, and many have thought that by suitably shaped propellers success might be attained; but to those who have closely observed the flight of birds on leaving the ground, it has been apparent that unless an initial horizontal velocity is first attained by running on the ground or by webbed feet against the water, as in the case of a duck or swan; once again a plunge from an elevated position that, without such initial help, the bird has to exert a very abnormal effort to rise at all.

"From experiments I made about 1890, I came to the conclusion that when in steady, horizontal flight, the power required to maintain the motion did not exceed one-tenth of that necessary to rise vertically from the ground.

"If the lifting screw is made very large in proportion to the weight of the apparatus, the slip and the power required for a given weight is diminished, but the apparatus becomes unwieldy, and is readily distorted or upset by wind.

"On the whole, I do not think that the helicopter type of machine is at all promising as a competitor of the gliding machine, which is always coming on to fresh air, which supports it with a minimum of slip and consumption of power."

(C) *Underwood and Underwood* FORWARD PORTION OF A GERMAN TWO-SEATER FIGHTER



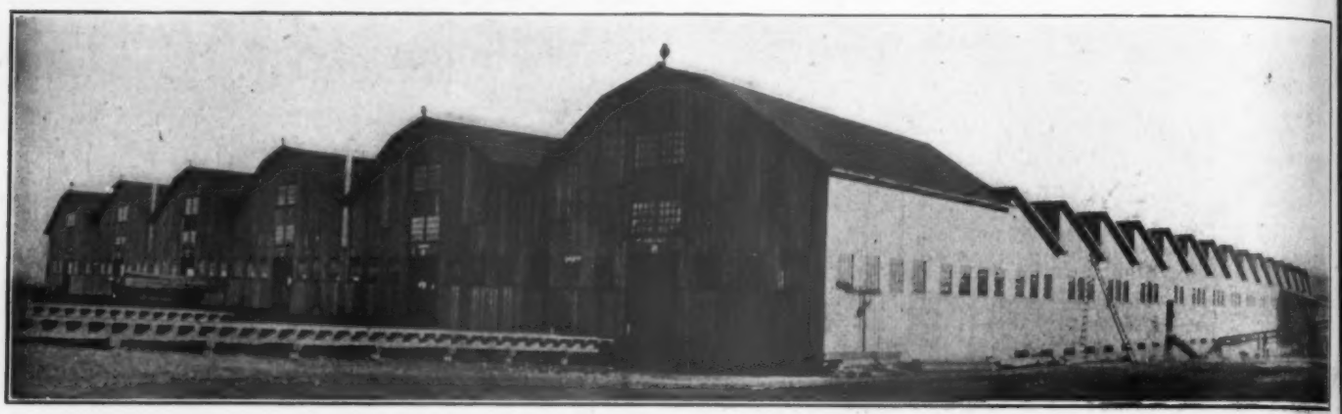
(C) *Kadel and Herbert* PUSHER BODY OF A FRENCH FARMAN SCOUT

The Largest Cut-Up Plant in the World

By J. Frederic Thornel
Portland Chamber of Commerce

The largest cut-up lumber mill in the world is owned by Uncle Sam and is located at Vancouver Barracks just across the river from Portland, Oregon. It is under the direct control of the Spruce Production Division of the Signal Corps of the Army, Colonel Brice P. Disque commanding.

The main building of the plant is 348 x 400 ft. and the shipping sheds 60 x 500 ft. The output capacity is from 400,000 to 600,000 ft. of airplane stock sizes every twenty-four hours, with three or four shifts totaling about a thousand men. Maximum cutting length for timbers is 40 ft. Each unit of the plant contains two circular saw rigs, one right and one left, carrying 48 in. No. 9 gauge saws.



GENERAL VIEW OF THE SPRUCE CUT-UP PLANT AT VANCOUVER BARRACKS
Photo Gifford and Prentiss

Arrangement of the Plant

The carriages are three and four block type. Back of the saw rigs are two table edgers, two re-saws and eight trim saws in each of the six units. It is expected that dry-kiln facilities for about 50 per cent of the output will be installed, requiring a boiler capacity of 1500 hp. The entire plant is electrically driven and every safeguard against accidents is given the workmen.

The arrangement of the plant provides for the installation of two locomotive cranes running parallel to the unloading track for the easy and convenient handling of cants from the railroad cars to the transfer cars, operated by gravity into the mill. The outgoing loading track is at the rear of the plant. The locomotive cranes also are used to pile up cants alongside the railroad tracks before they are carried to the mill for resawing. Electric cranes pile up the cants while a system of conveyors under the floor transfers the refuse to the fire-room where it is used for generating the steam for the dry-kilns.

The plant is equipped with twelve pony carriages, which are calculated to give it a daily capacity of 600,000 ft. It is protected by a double line of guards and a great battery of search lights.

The location of the plant is as nearly ideal as any manufacturer could wish or expect. There is just enough slope for natural drainage, adequate fire protection and a complete sewerage system. The housing of the soldiers who will assist in the operation of the plant is in close proximity.

LOADING LUMBER AT VANCOUVER BARRACKS
Photo Gifford and Prentiss

Eliminating Cross-Grain Material

In discussing the spruce that will be worked at this mill one of the men in charge says:

"A considerable supply of hewn, sawed and rived cants are already on the ground and more are arriving each day. The plant will be operated on a twenty-four hour basis, with four crews, working six hours at a shift, with twelve hours off.

"Cross-grain has been one of the chief causes for rejection of airplane material at the Eastern factories. Elimination of cross-grain has therefore been one of our problems. All logs have some taper, and by beginning to saw at the butt end in the usual way you cut across the annular rings, which are parallel to the bark. In order to cut straight grain lumber it is necessary to start at the butt end, cutting, say, two inches in, and then come out at a depth of two inches at the other end of the log. This produces straight grain. This method is not necessary to obtain commercial stock, but the stress which falls upon airplane material makes it absolutely vital that this lumber be sawed to get actual straight-grain stock. This plan must be followed in order to get straight-grain lumber from the mills for the remanufacturing plant.

"At the Vancouver plant the lumber will reach us in the form of flitches four and six inches thick. These will first be surfaced one side by the planers. The grain will thus be brought out clearly, and especially it will then be possible to detect spiral grain, which cannot be passed under any circumstances. With the grain now plainly visible, the next step is the marking of the piece for resawing, which will be done to eliminate all defective portions. The material will then be airplane parts in the rough. The next step is the kiln drying. The material will all be classed as to size in going to the kilns, the larger pieces, which require more time in the kilns, being segregated from the smaller, which will dry faster. Beam stock will take about twelve days and smaller

parts seven days. It is probable that a small testing laboratory will be maintained to insure that the material has not lost its strength in drying. Cross and spiral graining are the most treacherous defects that can exist in airplane lumber."

Draft Soldiers Commended

In an address to the soldiers working at the plant Colonel Disque said:

"I have commanded regular troops for a great many years and have never seen a spirit comparable to that which you men have shown in the construction of this plant. You worked for days without raincoats and proper equipment and went right ahead without a grumble, doing it on soldier pay because with the enormous problems our great government has to solve it has been impossible to get the matter of proper pay straightened out. You have not complained about what you did not have, although you did not have mattresses and necessities part of the time. That spirit from drafted men in the American army speaks well for the saving of our democracy.

"Now men, this plant is yours, yours to run and we expect you to keep it. Do not permit little violations of rules that will creep in sometimes. We cannot afford to take any chance with the continued operation of this plant, now complete. Arrangements are rapidly being completed whereby you men employed in the plant will be given what you were promised when you came, that is the going wages of the community. I think every man here should be proud to belong to this organization and I think all of you feel that this mill, completed in forty-five working days from the time started stands to your credit as a monument to the loyalty and efficiency to-put-it-over of the American soldier of our army today and I am mighty proud to be in command of this organization."

The government is paying for rived spruce $90 per thousand board feet, with a bonus of $30 additional up to June 30. For sawed spruce the price paid is $105 per thousand. Operators are paying to owners of timber land a stumpage of $7.50 per thousand. Of course, all material is accepted only after rigid inspection according to the specifications of the Spruce Division.

In addition to the spruce there have been received in Portland recently orders from the United States, French, British and Italian governments for aircraft material aggregating a total of about forty million feet, part of which already has been shipped. All similar orders placed by foreign governments will be handled on shipping instructions from the Spruce Production Division headquarters.

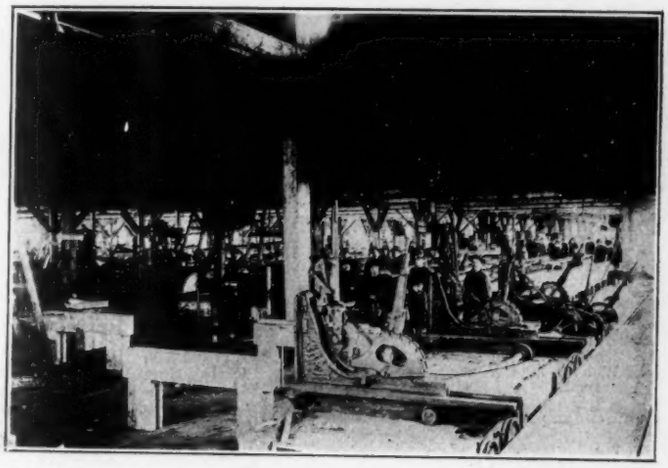
RIVED OREGON SPRUCE
Photo Gifford and Prentiss

In dollars and cents this industry that is essentially new means more to the entire Pacific Northwest than any other enterprise heretofore or now in existence. Nor is it apt to cease with the end of the war.

We are indebted to *The Timberman*, lumber publication on the Pacific Coast, for the following tables, which are self-explanatory:

What 11,000,000 Feet of Airplane Spruce Monthly Means

To secure 11 million feet of airplane spruce monthly from stands of timber running 10 per cent spruce, assuming that the logs produced would yield 10 per cent airplane cuttings, it would mean that 1,100,000,000 ft. of timber of all kinds would have to be logged monthly, or 13,200,000,000 ft. annually. Computations in tabular form for logs yielding 10 to 30 per cent of airplane cuttings on the basis of 10 to 30 percent stands of spruce are as follows:



INTERIOR VIEW OF THE PLANT
Photo Gifford and Prentiss

COMPUTATIONS FOR 10 PER CENT SPRUCE STAND

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	1,100,000,000	13,200,000,000
15%	733,333,333	8,800,000,000
20%	550,000,000	6,600,000,000
25%	440,000,000	5,280,000,000
30%	366,666,660	4,400,000,000

COMPUTATIONS FOR 15 PER CENT SPRUCE STAND

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	733,333,333	8,800,000,000
15%	488,888,840	5,866,666,000
20%	366,666,667	4,400,000,000
25%	293,333,333	3,520,000,000
30%	244,444,420	2,933,333,000

COMPUTATIONS FOR 20 PER CENT SPRUCE STAND

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	550,000,000	6,600,000,000
15%	366,666,630	4,400,000,000
20%	275,000,000	3,300,000,000
25%	220,000,000	2,640,000,000
30%	183,333,330	2,200,000,000

COMPUTATIONS FOR 25 PER CENT SPRUCE STAND

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	440,000,000	5,280,000,000
15%	293,333,370	3,520,000,000
20%	220,000,000	2,640,000,000
25%	176,000,000	2,112,000,000
30%	146,666,630	1,760,000,000

COMPUTATIONS FOR 30 PER CENT SPRUCE STAND

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	370,000,000	4,440,000,000
15%	244,444,420	2,933,330,000
20%	185,000,000	2,200,000,000
25%	146,666,630	1,760,000,000
30%	122,222,220	1,466,000,000

Selective Spruce Logging

On the basis of selective spruce logging, i.e., the removal of the spruce trees only, we have calculated the amount of spruce timber that will be necessary to be logged to yield 11 million feet of airplane material monthly:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (Spruce only)	Ft. to be logged annually. (Spruce only)
10%	110,000,000	1,320,000,000
15%	73,333,333	880,000,000
20%	55,000,000	660,000,000
25%	44,000,000	528,000,000
30%	36,666,666	440,000,000

Extract from comparative table compiled by Forest Products Laboratory, United States Forest Service, Madison, Wisconsin:

PROPERTIES OF WOODS FOR USE IN AIRPLANE DESIGN

(*Strength Values at 15 Per Cent Moisture*)

	Spruce, Red White, Sitka (Picea Rubens, Canadensis, Sitchensis.)	Pine, Western Yellow or Calif. White Pine (Pinus Ponderosa.)	Pine, Sugar (Pinus Lambertinna.)	Fir Douglas.
Specific gravity based on volume and weight when oven-dry:				
Average	41%	42%	39%	52%
Minimum	36%	38%	36%	47%
Weight at 15% moisture:				
Lbs. per cubic foot	27	28	27	34
Shrinkage from green to oven dry condition:				
Radial	3.9%	3.9%	2.9%	5.0%
Tangential	7.5%	6.4%	5.6%	7.9%
Static bending:				
Fiber stress at elastic limit. Lbs. per square inch	5,100	6,800	5,300	6,800
Modulus of rupture. Lbs. per square inch	7,900	8,700	7,400	9,700
Modulus of elasticity. 1,000 lbs. per square inch	1,300	1,300	1,100	1,780
Work to maximum load. Inch lbs. per cubic inch.	7.4	6.7	5.0	7.2
Compression parallel to grain:				
Maximum crushing strength. Lbs. per square inch	4,300	5,000	4,300	6,000
Compression perpendicular to grain:				
Fiber stress at elastic limit. Lbs. per square inch	500	640	540	750
Shearing strength parallel to grain:				
Lbs. per square inch	920	1,040	950	1,020
Hardness side:				
Load required to imber. 0.444 inch ball one-half its diameter. Lbs.	430	430	410	580

The Latest in Airship Design

BRITISH NAVAL AIRSHIP OF THE N. S. (NORTH SEA) CLASS OVER TRAFALGAR SQUARE—THIS VESSEL SHOWS CLEVER COMBINATION OF AN ASTRA-TORRÈS HULL WITH A FORLANINI TYPE OF CAR

Central News Photo Service

Book Reviews

CAVALRY OF THE CLOUDS. By "Contact" (Capt. Alan Bott, M. C.). Doubleday, Page & Co., Garden City and New York. ($1.25. 266 pp.)

Among the large number of books dealing with aerial warfare which have appeared since the outbreak of the Great War, a few stand out by virtue of their intrinsic qualities. Some of these will in due time become classics of war flying literature. CAVALRY OF THE CLOUDS undoubtedly belongs to this class.

The volume reviewed was written by a fighting aviator belonging to a crack squadron of the Royal Flying Corps which, during the battle of the Somme, held the record in the number of its losses. Once eleven of its machines were posted as missing in the space of two days, a circumstance, the author notes, which had never yet been equaled in R. F. C. history. That the squadron possessed an excellent fighting record, even among the enemy, was shown in a letter found on a captured German airman, who referred ot it in the following terms: "The most to be feared of British machines is the Sopwith."

Captain Bott has the rare gift of presenting his subject in a style at once vivid and expressive; one which conveys even to the non-initiated the secrets of war flying in a most thrilling and, at the same time, technically correct manner. Students of aerial warfare will find it worth their while to absorb this book in a thorough way, for it gives in an easily readable style more practical information on aerial tactics than many a more abstruse treatise.

CAVALRY OF THE CLOUDS is prefaced by Major-Gen. W. S. Brancker, late Deputy Director-General of Military Aeronautics of Great Britain, a fact which vouches for the real value of the book.

MILITARY OBSERVATION BALLOONS (CAPTIVE AND FREE). By Emil J. Widmer. D. Van Nostrand Co., 25 Park Place, New York. ($3.00. 151 pp., 3 plates and 38 ill.).

This book, which is based on the Balloon Manual of the German Army, gives a very comprehensive survey of the manufacture, equipment, inspection and operation of kite-balloons, as well as of the drill and organization of the German balloon troops as it existed prior to the war.

Although the Parseval-Sigsfeld kite-balloon, which is described in detail in the book reviewed, is no longer being used by the aircraft troops of the Allies, its place having been taken by the much handier Caequot kite-balloon, the basic principles ruling the construction and operation of these craft have remained the same; from which it follows that, since the subject is very capably set forth, the present volume constitutes an excellent text-book on the subject of free and captive balloons.

THE GAS MOTOR. By Max Kushlan, B. S., Ass. M. W. S. E. The Branch Publishing Co., Chicago. ($2.50. 366 pp. and many ill.).

This volume is intended as a practical manual for operators and students of internal combustion engines, and appears to satisfy this purpose as far as automobile practice is concerned, for the greater part of the book is devoted to the study of the automobile engine, though an interesting chapter is set aside for the stationary gasoline engine, and reference is also made to various types of aero-engines. In the latter connection it might be regretted that the author has not seen fit to give a description of a thoroughly modern aero-engine. Such examples as are given are cited in a perfunctory manner and belong mostly to obsolete, or else experimental, types, such as the Vivinus, Farcot, Gobron-Brillé, etc., which naturally are little representative of modern aero-engine design.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE. By A. L. Dyke, St. Louis, Mo. (Seventh edition. $3.50. 916 pp., fully illustrated.)

The seventh yearly issue of this reference book on the construction, operation and repairing of automobiles should prove of particular interest to the air mechanic, because it includes, for the first time in the history of this publication, a brief but sufficiently wholesome supplement on aviation. Although but sixteen pages are devoted to this subject, the information given is quite comprehensive, and particular attention is paid to the mechanism of some well-known aero-engines, such as the Monosoupape Gnôme, the Hall-Scott, the Mercédès, and others.

Aircraft Situation from a Manufacturing Viewpoint

For the first time it is now possible to present an authoritative composite of certain constructive ideas of leading aircraft manufacturers as to how quantity production of aircraft may be obtained and obtained quickly. The manufacturers are apparently in accord in the belief that the time has arrived to place the entire responsibility for the development of the air program in the hands of a civilian executive with complete power to make immediate decisions upon engineering and production matters. Their views in this and one or two other respects closely parallel the majority report made by the Military Affairs Committee of the Senate and the forecast of some of the recommendations of the President's special committee investigating the aircraft situation headed by H. Snowden Marshall and published in the New York *Times* of April 13. These views were, however, expressed before the Senate report was published or the Marshall recommendations had been made to the President.

The first and most compelling fact is that one of the largest producing aircraft plants will have to close down within two weeks for lack of orders.

Manufacturers of aircraft as a whole are understood to have practically no *definite* orders at the present time. They must have continuing and overlapping orders to keep their plants running at full capacity; they must also have definite instructions to proceed with the manufacture of machines, orders for which have been *tentatively* placed.

The best machines should be quickly decided upon, a schedule laid out and the way cleared for uninterrupted production of a definite number of planes without permitting the incorporation of changes in that lot. While these machines are being turned out, changes suggested by experience or necessity could be worked out in time for incorporation in the succeeding specific number of planes. The result would be to progressively incorporate the latest improvements without retarding production.

If some definite action is not taken immediately, the result will be to completely disrupt organizations which it has taken the better part of a year to build up, and further serious delay may be looked for in carrying out the airplane program.

Certain manufacturers have been going ahead practically upon their own initiative and at their own risk in their genuine desire to accomplish *something*. They are assuming a risk they should not be called upon to assume.

Advantage has not been taken in the past of the skilled engineering and production forces of the aircraft manufacturers. This has resulted in the suppression of original effort in design and construction. In fact the policy seems to have been to actually prevent experimental work. On the other side too much reliance has apparently been placed upon automobile production methods. It would be fatal to consume a year in improving a proven foreign airplane, although that is the time usually necessary to bring out a new automobile model. There is sufficient talent and creative genius among American aeronautical engineers trained in American production methods to not only copy or adapt foreign machines but to produce all-American training, fighting or bombing machines for use with the Liberty and other proven American and foreign engines, if full opportunity is given them.

The manufacturers welcome the most severe Government inspection; in fact they insist upon it. They should be permitted, however, to substitute materials of equivalent quality if specifications cannot be lived up to without involving delays.

The constant flow of reliable information from responsible officials to the manufacturers is essential. Under present conditions the manufacturer is usually given a tentative order for a machine which is understood to be ready for production. He must prepare his plant, build up his force and place his orders for material. It has been the rule rather than the exception for serious loss of time to result before official information or data is available upon which the work can be actually started. It may be that a model machine is not available or specifications or bills of material are held up. The result is obvious.

It has been impossible for manufacturers to estimate at all as to the probable outcome of their work from a financial standpoint. This has been due to the acceptance of a type of machine today and its abandonment immediately afterwards, or to changes in design which involve the entire disruption of schedules. It has been a common experience for delay in receipt of essential accessories ordered direct by the Government to hold up the delivery of machines for weeks.

When an order is placed, the manufacturer should be immediately given all available information in regard to the machine in question. He should be permitted to go ahead under his own methods and produce the first machine. At the same time production drawings, specifications and bills of material are keeping pace with the actual construction of the first machine. With the acceptance of the first machine and a definite schedule laid out for its production, no changes should be permitted until the completion of the number agreed upon in advance. A clause in some of the contracts is intended to safeguard the manufacturer from the necessity of making changes prior to completion of a specific number of machines. But in practice this has not worked out. Notification of change comes to the production department with definite instructions to withhold fabrication of the various parts. Despite the contract clause it has been found necessary to suspend production, and even though the parts were produced according to the contract arrangement the Accounting Section of the Signal

PRODUCTION ESSENTIALS

1.—Orders should be placed at once for a sufficient number of planes to prevent the closing of productive aircraft plants. A continuing manufacturing program should be decided upon without further delay.

2.—Immediate "go-ahead" orders should be given for the completion of a definite number of machines without changes.

3.—Changes and improvements, where indicated by experience or necessity, to be made in the next specific lot of machines.

4.—Full advantage should be taken of the experienced engineering and production experts of the aircraft manufacturers.

5.—Substitution of materials of equivalent physical characteristics and strength should be permitted, when it is impossible to live up to specifications without involving delays.

6.—A direct channel for the constant flow of information from the responsible government official to the contractors should be opened. When an order is placed the manufacturer should be immediately given all available information regarding the particular machine or machines.

7.—Orders for complete machines should be placed with responsible contractors who should be held strictly responsible to the Government under their bonds for the delivery of a definite number of machines.

8.—Simplification of Government cost accounting methods in the plants, so as to eliminate innumerable minor and technical disputes between Government accountants and the manufacturers which result in retardation of production.

9.—Original American creative work and design should be encouraged in every way.

10.—The appointment of a civilian executive in whom may be lodged the entire responsibility for the development of the American air program.

Corps would be unwilling to pass an invoice for the parts on the ground that they had become obsolete.

The experience of one of the manufacturers in reproducing the triple engined 78-ft. spread Caproni biplane is illuminating in showing what can be accomplished by the actual application to a private contract between the Italian Caproni Company and the American manufacturer, of the practice outlined above. The original machine arrived at the plant on January 25th. Before sixty days had elapsed this manufacturer had translated and reproduced the drawings and specifications from the metric system and Italian language to the English language and measurements, had prepared his schedule and commenced the fabrication of parts. Within approximately four months from Janury 25th it is expected that the completed and fully equipped plane will be in the air, and during the interval all production drawings will have been completed. This is not cited as an extraordinary achievement, but it stands out notably when compared with what has been accomplished in the past nine months in adapting other foreign machines to American production under the system now in effect. In this case the manufacturer was permitted to substitute materials of equivalent strength, weight, etc., where those called for in the specifications could not be obtained or could not be secured promptly. And the reproduction of the big Caproni has involved an infinitely greater task than that of building the smaller and less complicated DH-4 machines.

It has been demonstrated that it is entirely feasible to reproduce a DH-4 machine in one plant within forty days by practically copying the model without the advantage of complete drawings and specifications. In this instance, although many of the drawings had not been officially released, the details were checked from the original machine, the drawings were checked, and the manufacturer has laid out his own production drawings. This machine is now ready for quantity production, despite which fact the plant today has no information as to the installation of the fighting equipment, and without this information the machine cannot be put into production.

The question of responsibility between the Government and the manufacturers should be definitely and finally decided. There should be undivided responsibility on the part of the executive who is made responsible for the production of airplanes. In the same way there should be unqualified responsibility on the part of the manufacturer for the machines which he may contract to produce. With definite orders to proceed, large contractors should be permitted to develop their own sources of wood and metal parts to be turned out by sub-contractors responsible to themselves and not to the Government. The Government's cooperation in facilitating sources of raw materials and in giving priority to shipments is obviously essential. But undivided responsibility should rest with the manufacturers for the completion of their contracts.

Under existing conditions many parts are ordered directly by the Government from outside, and frequently far distant, sources over which the contractor has no control and with which there is no point of contact. The result is that these parts come to the main contractor before they are wanted, or long delays in their receipt may result, with resultant serious delay in the completion of machines for which the contractor is in turn directly responsible to the Government under his bond.

The aircraft manufacturers are instruments of the Government in the performance of a great task. Through Government accountants, production officers and inspectors in the plant they are practically Government owned and operated. The effect of hampering minor restrictions and regulations is to place them in the position of having to continually demonstrate their integrity and good faith. This artificial attitude of suspicion should be removed. It does not obtain between individual officers and plant officials and employees, and the complicated system which creates this feeling should be abandoned.

Until a manufacturer is proven unworthy, he should be given equal credit with other Americans for patriotism and an absorbing desire to help win the war.

The opinions of Government aeronautical engineers, production and efficiency engineers should be subordinated to the main idea of securing production. Technicalities must not be permitted to interfere with turning out machines.

There is absolutely no disposition on the part of the manufacturers to criticize individual officers of the Signal Corps. It is the system that the manufacturers are against. These officers are appreciated for what they are—splendid officers and gentlemen, who have been laboring night and day for many months on an unprecedented task—the fourfold burden of building up an enormous executive force, the construction of flying fields, training of a commissioned and enlisted personnel which numbered on January 1, 1918 (according to published testimony before the Military Affairs Committee of the Senate) 3900 officers and 82,120 men, as against 65 officers and 1120 enlisted men on April 1, 1917, coupled with the responsibility for an unparalleled aircraft program. This responsibility has been both thrust upon them, has been assumed and has grown from the very exigencies of an unprecedented situation, at the bottom of which is the fundamental difficulty, unpreparedness, for which they are in no way responsible. The only wonder is that the sum total of accomplishment so far outweighs admitted mistakes and failures on the part of both manufacturers and the Government.

If the Service is now relieved of responsibility for aircraft production, unstinted credit must be given to it for doing the hard and thankless preliminary work under a system which has always tended to confuse and nullify the most prodigal effort. Although the "peak of production" which it was predicted by the Secretary of War some time ago would be reached by now is still in the distance, the "peak of production *difficulties*" undoubtedly has been reached and passed. From now on a progressive improvement is confidently to be expected. But the most effective results will be obtained by placing the entire responsibility for aircraft engineering and production where it belonged in the beginning—in the hands of an all-powerful civilian executive whose quick and final decisions must be based upon the latest military and civilian aircraft engineering knowledge and military information, and upon a determination to secure the best in the long run, but in the meantime to get into production with every proven type of plane required by our student and fighting aviators. This executive will needs be given broad powers to circumvent technicalities, routine and red tape. To the air services of the Army and the Navy will remain the inspiring duty for which they were trained, that of building up the personnel and manning the machines that are destined to win the war.

Senate Committee Recommends Single Aircraft Head

On April 10, the Committee on Military Affairs of the Senate submitted to that body a report of its investigations into the aircraft situation. The majority report recommended that a civilian head with broad powers be appointed to direct the production of aircraft, and that this work be divorced from the Signal Corps. A minority report defending the work of the Signal Corps was also rendered. Both reports are printed herewith in full.

THE MAJORITY REPORT

The Committee on Military Affairs, being engaged under authority of the Senate in an investigation of the War Department, and having taken much testimony, herewith submits the following report in the matter of aircraft production, together with certain recommendations:

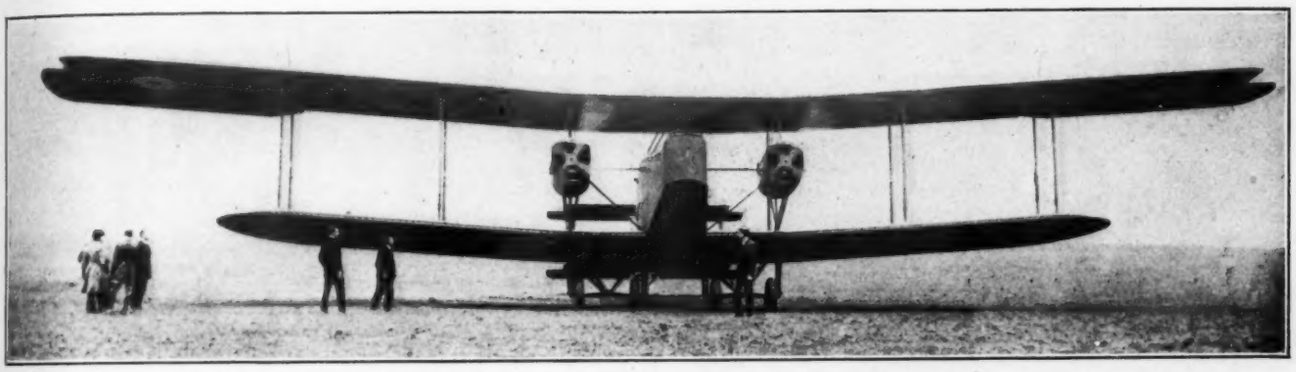
Training Schools

The Signal Corps has established and is now conducting 20 aviation training schools in the United States. Four additional schools are in process of construction and are expected to be finished in June next.

The aggregate capacity of the schools now in operation is something over 3,000 cadets. One thousand nine hundred and twenty-six have thus far been graduated from this primary training course and commissioned as reserve military aviators. Very few of these have received their advanced training in this country.

In addition to the above, the Signal Corps, acting upon the invitation of the several Entente Governments, dispatched some 1,200 cadets to England, France, and Italy last year, who were to receive primary and advanced training in aviation schools

of those countries. The experience of a great many of these men has been most unfortunate in that at some of the schools a very serious delay has occurred in providing them with the training planes, which it was expected would be manufactured in foreign factories in sufficient number. As a result, several hundred of the American cadets have been practically idle and have made no progress. About 450 of them are reported as having completed the primary training, after long delay. The Signal Corps is giving serious consideration to the advisability of bringing the remainder back to the United States to be trained. With the exception of this severe disappointment, the primary training of our aviators, according to the testimony of the aviation officials, appears to be progressing favorably. The health record of the schools is excellent and the fatalities arising from aviation accidents, while always distressing, appear to be less frequent than in the schools of our allies, according of the testimony of the Chief Signal Officer.



FRONT VIEW OF A RECENT MODEL OF THE HANDLEY-PAGE TWIN-ENGINED BOMBING BIPLANE
Central News Photo Service

Training Planes

For some time after the inception of the work the output of primary training planes in this country for use in our schools gave ground for grave concern. In recent weeks, however, the output has been greatly increased and there seems to be no doubt of the Signal Corps having an amply sufficient number in the future. On April 1, 1918, 3,458 primary training planes had been completed. The planes are of two standard types developed for the purpose and are equipped with Curtiss and Hall-Scott motors, respectively. The advanced training planes are being turned out in accordance with the schedule and estimates laid down at the inception of their manufacture. In advanced training planes four types are being made, the total number up to date manufactured being 342. In these planes three types of engines will be used, of which 965 have been completed. These include the Gnôme, Le Rhône, and Hispano-Suiza, all of foreign design but American manufacture. The Liberty motor is not suitable for use in these planes.

The Liberty Motor

It is apparent from the evidence that the 12-cylinder Liberty motor is just emerging from the development or experimental stage. Since the original design and the setting up of the first completed motor in July, 1917, a large number of changes have been found necessary, many of them causing delay in reaching quantity production. Within the last two months changes of considerable importance have been made which, it is hoped, will make the motor serviceable for combat planes of the defensive type, and for bombing and observation planes. It is not designed for and can not be used in the swift, single-seater fighting machine. A few of the motors are being flown in appropriate machines. These reports, as recited to the committee, indicate that with the latest changes the motor will be satisfactory for the character of work expected of it and that it bids fair to hold its own with foreign motors of similar power, weight, and purpose. For the campaign of 1919, the Liberty motor must undoubtedly be further improved in order to keep up with the evolution constantly going on along the front. The motor as now manufactured is of the direct-driven type, a type which has limits of usefulness in heavy machines.

Steps are being taken in the designing of a geared drive, in order that the usefulness of the motor may be further extended and further improvements attained. Twenty-two thousand five hundred Liberty motors have been ordered, 122 have been completed for the Army, and 142 for the Navy. Four have been shipped overseas. Some of those already delivered are being altered to overcome the defects ascertained during the last few weeks. It is understood, however, that these alterations will consume but a very short time.

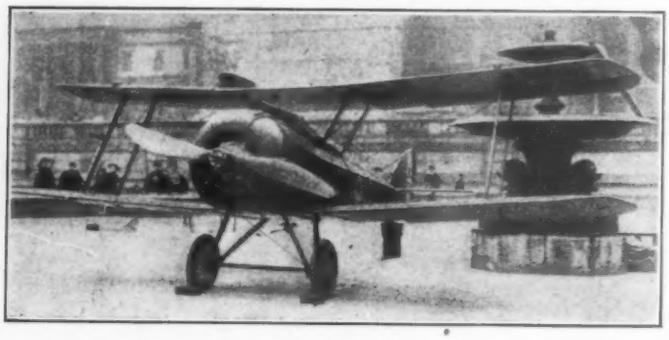
The production of Liberty motors to date is, of course, gravely disappointing. The testimony shows that experts of the highest reputation and experience have, since last July, repeatedly warned the officials of our Government that the perfecting of a newly designed motor must inevitably involve many months of painstaking experiment accompanied by many setbacks and disappointments. In spite of the unanimous testimony of motor experts along this line, the Government officials having the manufacture of the Liberty motor in charge have made the mistake of leading the public and the allied nations to the belief that many thousands of these motors would be completed in the spring of 1918. Information of this sort, not borne out by the facts, has been injurious, and its constant dissemination the committee regards as misleading and detrimental to our cause.

Combat Planes

The production of combat planes in the United States for use in actual warfare has thus far been a substantial failure and constitutes a most serious disappointment in our war preparations. We had no design of our own; neither did we adopt any one of the European designs until months after we entered the war. Much time was consumed in discussion as to types. Innumerable changes in designs and specifications of the types finally decided upon have cost further delay. In all, five types have, at one time or another, been adopted. Two of them have been abandoned after the expenditure of much time and money. The three remaining types still left upon our program are now in the course of manufacture. Of these, the largest and most powerful is the Handley-Page heavy bombing machine, designed to carry as many as six men, eight machine guns, and a heavy load of bombs, and to be driven by two Liberty motors. The history of the negotiations for the adoption and manufacture of this plane afford a remarkable illustration of procrastination and indecision, too long to recite. Suffice it to say that the designs and specifications of this plane which has been used with marked success by the British and placed in production by that Government, were offered to our officials as early as May, 1917. The testimony before your committee shows that the Signal Corps finally decided upon the manufacture of a number of sets of parts of this machine about January 1, 1918. Eventually the finished and tested parts will be shipped to England, where they are to be finally assembled in factories now being prepared for this work. Officials of the Aviation Section of the Signal Corps testify that they do not expect the completion of the first set of parts in this country before the month of June, 1918.

Another type of combat plane, know as the De Haviland, is included in our program. This machine habitually carries two men, four machine guns, a moderate load of bombs, and other apparatus and is to be driven by one Liberty motor. Fifteen have been completed; 1 has been shipped to France; the remaining 14 have been very recently completed in this country. Some of these have been tested, propelled by a Liberty engine, and appear to have given satisfaction. The

third type upon the program is known as the Bristol fighter. This machine is lighter and faster than the De Haviland. Its speed is expected to be in the neighborhood of 125 miles per hour. It is what is known as a reconnoissance machine. Another term which might be properly applied to it is "defensive fighter." It carries two men, four machine guns, and is driven by one Liberty motor. The decision to make this type was reached on November 7, 1917. The manufacturers completed the first of these machines during the week ending March 30, 1918. The machine was tested once during that week with a Liberty motor, and, according to the testimony of the aviation officials, met its preliminary test successfully. This machine, a few hours after its flight, caught fire while standing upon the aviation ground and was entirely destroyed. The officials of the Signal Corps assured the committee that another machine would soon be finished by the manufacturer and that if it met the tests satisfactorily quantity production might be expected within a reasonable period. The testimony as to this machine was given on April 2, 1918. This completes the list of machines now under manufacture and con-



BRITISH D. H. 5 FIGHTING BIPLANE

stitutes a correct statement of the situation in this country as of April 1, 1918. In addition to the American production of engines and airplanes as herein set forth, considerable orders for combat airplanes and engines were last summer placed with European manufacturers by Gen. Pershing, and we have furnished quantities of material and numbers of mechanics to aid in their construction.

Your committee has full information as to the number and quantity of machines and engines ordered here and abroad but does not feel justified in stating the number in this public report. The facts contained in this report are drawn from the testimony of the Chief Signal Officer, Gen. Squier, Col. Deeds, and Mr. Potter, the chief of the Equipment Division of the Aviation Section of the Signal Corps, and are confirmed from other sources official and otherwise.

Your committee, being devoid of technical knowledge of motors and airplanes, does not undertake to point out in detail engineering and manufacturing errors which may have been committed and which, in part, may account for this gravely disappointing situation. Your committee, however, is convinced that much of the delay in producing completed combat airplanes is due to ignorance of the art and to failure to organize the effort in such a way as to centralize authority and bring about quick decision. A certain aloofness in dealing with persons possessing information based upon experience, an apparent intention of confining the actual production to a restricted number of concerns, and a failure of the officials in charge of the work to grasp the situation in a broader way and seize upon the best approved foreign engines and planes and proceed promptly to build as many as possible for the campaigns of 1918 has contributed to the failure. It is greatly to be regretted that the statements of Government officials have misrepresented the progress of the aviation program. This has misled the public, and your committee, cognizant of the facts, has, in the performance of its duty, made this report to the Senate.

Your committee believes that production of aircraft should be controlled by one executive officer, appointed by the President and responsible to him. He should be assisted by a corps of the best aircraft engineers and designers possible to obtain, both European and American. The matter of production should be taken out of the hands of the Signal Corps entirely, and no man who has any near or remote interest in a company manufacturing airplanes or engines should be permitted to act as adviser or be in authority. While we are developing American aircraft and American engines we should temporarily, at least, procure an abundant supply of approved types of aircraft and engines of European design.

Further, it seems to the committee that every encouragement should be given to the development of aircraft and that any action which retards progress, such as trust agreements or the prevention of those developing machines from flying, under proper restrictions, should be removed.

The committee also believes it to be its duty to point out that thus far no broad plan looking to future development has been laid down by the authorities. Warfare in the air is still in its infancy and it is inevitable that rapid changes will take place in both engines and planes. It is essential to our success that those in charge of the American aviation development shall be constantly looking ahead and devising plans for a continued expansion of the program, as well as the development of new types of engines and planes.

THE MINORITY REPORT

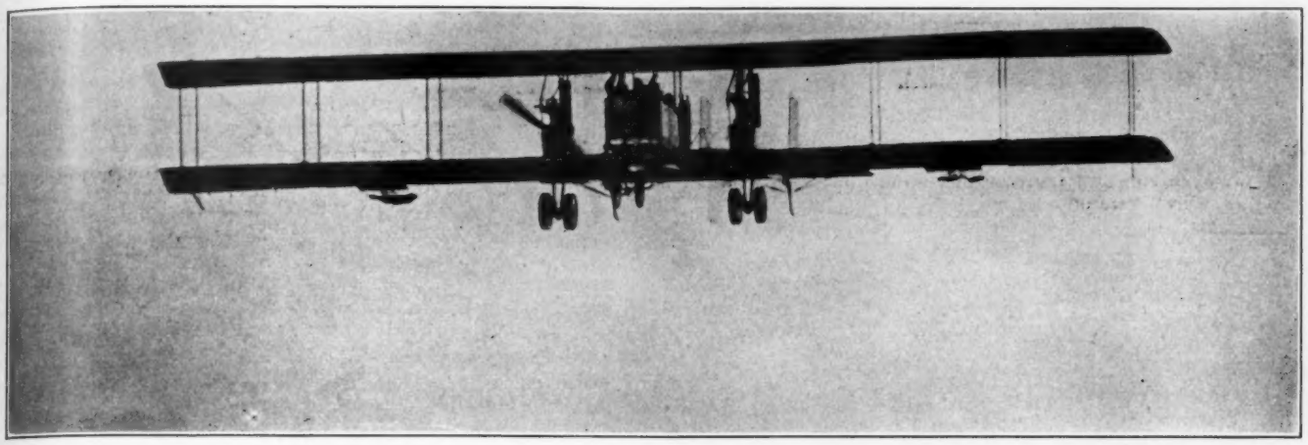
Following is the complete text of the minority report:

We do not believe that the report of the majority of the Senate Military Affairs Committee on the aviation situation shows a proper estimate of what is being accomplished or that it is sufficiently complete to give an accurate impression of the facts.

Soon after the war began the Signal Corps arranged with the French Government for the making of 6,100 combat planes at a total cost of $127,000,000, the planes to be produced as rapidly as American flyers could be trained to operate them. As the American aero squadrons reach the front ready for duty, battle planes are being supplied them under this arrangement. To aid in this foreign manufacture of planes for American flyers, the Signal Corps has shipped to France 11,000 tons of various materials and has sent 7,000 mechanics to release for French factories making planes for our American flyers the French workers on motor transports. The Signal Corps then arranged for the making of about 11,500 combat planes in the United States, the term "combat plane" being here used to embrace all kinds of planes, both offensive and defensive, except training planes. The Curtiss Aeroplane Corporation, the Dayton Wright Aeroplane Co., the Fisher Body Co., the Standard Aero Corporation, the Grand Rapids Aeroplane Co., W. H. Mullen & Co., and about 19 other companies throughout the country were engaged for the production either of completed machines or of spare parts.

Let it be said here that when the war began the United States Government had purchased altogether less than 200 airplanes in its history and that of the few airplane factories in this country probably not one was making over five or six a month. It is hardly possible to grasp the magnitude of the task the factories contracting to make the 15,000 combat planes found before them. New plants had to be constructed, old ones fundamentally changed. Special tools for the making of the planes had to be devised and manufactured and mechanics had to be trained to make the tools and also to make the planes after the tools had been completed. An airplane, especially the battle airplane, is one of the most highly technical, delicate, and complicated machines known to man. In no other form of machinery is absolute and painstaking accuracy in the smallest details more indispensable. It has about 4,000 parts and requires from 1,800 to 2,800 different drawings in the preparation for its manufacture, almost as many drawings as are required for a battleship. Every part is strained to the utmost while the machine is in the air and the slightest break almost anywhere means instant disaster. When it is remembered how often the wheels of railway trains, due to hot boxes, etc., parts of railway and automobile engines, tires on autos, etc., go wrong, necessitating immediate repair, and that any similar breakdown in an airplane would mean, as a rule, death to its occupants, some part of the responsibility and difficulty involved in making a finished plane may be understood.

Remember further, that every fighting plane must have machine guns, synchronizing devices, special telescope airplane sights, wireless apparatus, cameras of special type, electric heating devices for clothing, oxygen apparatus, speed indicators, special gauges, barometers, compasses, altimeters, etc. To say that this complicated equipment is in steady and adequate production, and that the factories are now about in shape for



THE THREE-ENGINED CAPRONI BOMBING BIPLANE FLYING OVER NEW YORK
(C) *Committee on Public Information*

quantity production of combat planes, and have about completed the foundation for what is as difficult and responsible a task as has ever fallen to the hand and brain of man, is to state the truth and at the same time to recite an achievement unparalleled in all history for so short a time.

Remember again that when these combat planes were contracted for the only known lubricating oil adapted to their delicate parts was an oil made from the castor bean. There were not enough beans in this country to make anywhere near the amount of oil required. Neither were there enough seeds with which to grow the needed quantity of beans. The Signal Corps had to search the globe for seeds and finally secured a shipload from distant India. Then the corps had to contract for the planting of the seeds in this country and has succeeded in having about 110,000 acres planted. It is now claimed that a form of petroleum has been developed that will answer the same purpose. This, however, is still in the experimental stage, while the oil from the castor bean is known to be entirely adequate and reliable.

Remember again that the cloth used in the wings of the airplanes of all types had to be treated with acetone, a liquid substance which makes the cloth as fireproof as possible and also strengthens it for the immense strain to which it is subjected in the air. The Signal Corps is having this acetone distilled from wool under its own supervision on an enormous scale and at a cost of about $20,000,000.

The corps has had to find a substitute for Irish linen as the material for wing cloths on training planes, and has succeeded in adapting a certain form of long-staple cotton to this need.

Coming now to the training plane, it may well be said that the completion of 3,500 to date and the fact that they are now in quantity production, practically according to program, constitute a remarkable achievement when the nature of the task is fairly weighed. The training plane is simpler than the battle plane, and for that reason could be produced sooner, but the making of the training planes on a quantity scale is in itself a task of unprecedented difficulty and magnitude.

Let it be remembered further that the Signal Corps had to put regiments of workers in the forests to find the spruce needed in the making of airplanes. The spruce trees are found among fir and other trees, and of each 100 feet cut only about 15 per cent is found sound enough for airplane construction. Approximately a billion feet of lumber had to be cut and inspected and tested before the necessary 100,000,000 feet of spruce could be obtained.

Propellers are made of mahogany and other highly durable woods, and three or four must be made for each machine. This mahogany comes from the tropics, and whether and when it can be brought to seaport depends on tropical rains which swell the rivers so as to permit transportation.

Let us now consider the Liberty motor. The Liberty motor could not fairly have been called an experimental and untried device. It represented a combination of what had been demonstrated to the best in all motor construction. The Signal Corps with its trained and skilled engineers understood that a foreign motor could not be adapted to American manufacture and turned out in sufficient quantity in anywhere near the time in which the Liberty motor could be produced. Foreign motors are based on the metric system of measurements, etc. American practice and American manufacture are not adapted to this system. All parts made under the metric system must be converted into inches and fractions of inches under our system. The foreign motor is so extensively the result of handwork that it is with great difficulty adapted to the machine work that dominates American factories.

Furthermore, the Liberty motor is capable of 100 more horsepower than any foreign motor except a few of one single type, the Rolls-Royce. The Liberty motor develops 400 horsepower ordinarily and is capable of 465. The foreign limit, with the one exception above mentioned, is 300.

The Liberty motor has become so well established that the British Government has asked for a large number. Sir William Weir, head of British aircraft production, stated recently in London that he considered the Liberty engine the greatest single factor in the world's aviation program, and that it was the most important single thing in the air program of England in 1918.

As soon as the Liberty motor had been designed, arrangements were made for the manufacture of a very large number before the close of 1918. The exact figures are withheld for military reasons. Henry Ford agreed to produce a substantial number of the total, the Packard Co. another portion, the Lincoln Motor Co., Nordyke & Marmon, General Motors, and the Trego Co. still other portions. These companies were notified to get ready last summer and the actual contracts were signed later. They have spent the intervening time preparing plants, tools, and workmen for this unprecedented work and are now on the eve of quantity production. The very names of these manufacturers are sufficient assurance that they would not take a day longer than necessary to lay proper and efficient foundations.

The foreign planes which were accepted by the Signal Corps, known as light battle planes or single seaters, for which the Liberty motor is too heavy in horsepower, were none of those offered by foreign concerns that came to America soon after the war began, to sell their wares, except the Handley-Page, and that was not the plane which the Handley-Page people first offered our Government on this side. Indeed, when the Handley-Page plane was first offered here it was untried and undeveloped and had not been accepted by the British Government. The Signal Corps sent a commission abroad to study foreign planes on the ground and accepted certain ones, only after careful and personal study.

On the whole the record of the Signal Corps is one of which every American can be justly proud. In the face of unparalleled difficulty it is accomplishing an unparalleled task with characteristic American energy, capacity, patriotism, and enthusiasm.

MARSHALL COMMITTEE REPORT

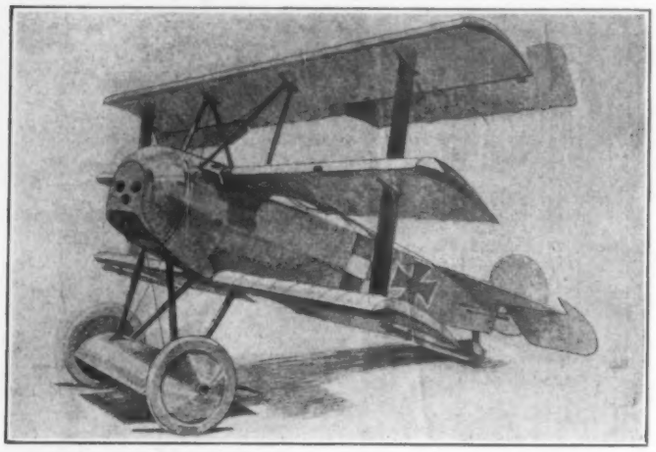
According to the New York *Times*, the main recommendations of the Marshall Committee are understood to be:

One man control of aircraft production; the divorce of the Signal Corps of the Army from aircraft production; legislation that will place the making of contracts for aircraft in the hands of another body than the Signal Corps.

Digest of the Foreign Aeronautical Press

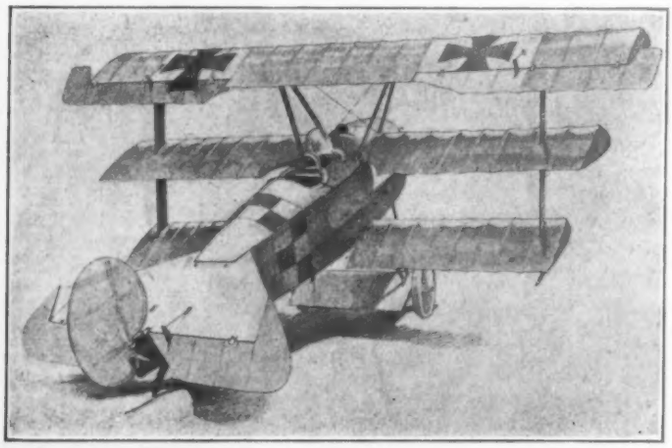
***Flight* (London), March 14, 1918**

The Fokker Triplane—It has been one of the features of the development of German airplanes during the war that, up till comparatively recently, their performance has been obtained by a constant increase in engine power rather than by highly efficient aerodynamical design. Of late, however, the Germans have been obliged to pay more attention to the question of streamlining and of this new tendency there resulted the Albatros D and C.V models.



THREE-QUARTER FRONT VIEW OF THE FOKKER TRIPLANE WITH THE ENGINE AND AIRSCREW REMOVED
From Flight.

The Fokker triplane marks a further step in the battle of reducing parasite resistance to a minimum. In this machine all external lift bracing is dispensed with, and the internal construction of the wings provides all the strength otherwise afforded by the flying and landing wires and the interplane struts. As a consequence, the interplane struts are really ties rather than struts, working as they do in tension, and their only function is that of distributing the load more evenly between the three wings.



THREE-QUARTER REAR VIEW OF THE FOKKER TRIPLANE
From Flight.

The absence of lift bracing naturally requires wing spars of considerable depth if the spar weight is to be kept low. On the Fokker triplane this has been attained by using a wing section very thick in proportion to the chord, the maximum thickness of this wing being a far greater percentage of the chord than hitherto found on any modern airplane.

The two wing spars are placed very close together, and are enclosed in a box of three-ply wood which satisfies the twofold purpose of increasing the strength of the spars for taking bending, and acting as internal drift bracing.

The upper wing, which is one piece, runs right across and is supported on struts sloping outwards as in the Sopwiths. The other two wings each have a center section rigidly attached to the body, the intermediate wing resting on the top longerons, and the lower wing running underneath the bottom longerons of the body, an aluminum shield streamlining the normal surface presented by the deep flat sides of this spar.

To make up for the low efficiency of the wings, which is due to their being set at an unusually small gap, very considerably less than the chord, and also to improve the range of vision, the wings are staggered forward. In addition to the three main wings there is a small lifting surface underneath the lower wing; this is constituted by a three-ply casing which encloses the wheel axle. This "axle-wing" probably carries a not inconsiderable load during flight, for its theoretical inefficiency due to low aspect ratio is considerably lessened by the disc wheels, which prevent marginal losses somewhat in the manner of the vertical panels of the cellular Voisin.

The body and the tail plane offer nothing not known in previous Fokker practice, steel tubes joined by welding being exclusively used in their construction.

While the Fokker exhibited at the Enemy Aircraft View Room in London, wherefrom this description was taken, was devoid of its engine, the cowling shows without a doubt that this must have been a rotary. Two synchronized machine guns are fitted in front of the pilot, one on either side of the body. The firing control is, as usual, through Bowden cables.

Painted on the side of the body are the following data relating to the weight of the machine: Net weight, 376 kg.; useful load, 195 kg.; gross weight, 571 kg.

Aerial Mails for Denmark—Quite a deal of useful work is being done by the Danish Aeronautic Society in preparing for aerial mail services which it is hoped to start when the war is over. Negotiations are pending with thirty-nine municipalities in the matter of constructing landing stations, including hangars 1300 ft. sq. Routes from Copenhagen to Odense, Frederica and Esbjerg, from Copenhagen to Kallundborg and Aarhus and from Copenhagen to Aalborg have been mapped out, and a route from the Danish capital to Gothenburg and Christiania is also planned.

***Flying* (London), March 20, 1918**

The Martinsyde Transatlantic Monoplane—At about the time the Curtiss Aeroplane Co. was completing the twin engined flying boat America, which Commander J. C. Porte, R.N., was to fly across the Atlantic, work was proceeding in England on a machine designed for the same purpose though fundamentally different in general outlay.

The English machine was a giant monoplane designed by the Martin and Handasyde firm, colloquially known as Martinsyde, and Gustav Hamel, a well-known English aviator, was chosen to fly it across the Atlantic. Hamel was unfortunately drowned in the Channel while bringing a new type of racing Morane monoplane for the 1914 Aerial Derby, from France, and this fact was really responsible for the subsequent abandonment of the attempt; the machine was never completed, although the main structure still exists. The wing area essential for the carrying of the great quantity of gasoline was considerable, being about 750 sq. ft. The wing span was 66 ft., the chord at the center of the main plane being 14 ft. 6 in., and tapering to 10 ft. 6 in. at the wing tip. The king post system was adopted for the wing bracing, while the motive power was a 250-hp. Sunbeam, driving a four-bladed airscrew of 12 ft. diameter. The gasoline tank, a huge cylindrical affair, with domed ends, had a capacity of 350 gallons, weighing approximately one ton. It was intended that the wheel structure, which was independent of the main skid, should be cast off immediately the machine had risen, thus reducing the total weight, and the subsequent landing was to have been made on the main central skid, and one or other of the king post skids. The general design of the machine was a distinct and somewhat ambitious advance on contemporary practice, and in the matter of type and dimensions it has had no successor.

It is interesting to note, in view of future historical reference, that the original plans of the Curtiss-Wanamaker trans-Atlantic flyer contemplated a system of shedding the undercarriage very similar to that of the Martinsyde.

News of the Fortnight

Progress of Postal Air Plans

According to official announcements made by the Post Office Department the question of obtaining satisfactory landing stations for the proposed aerial mail route between Washington, Philadelphia and New York, has been definitely solved.

The Washington terminal will be located on the polo grounds in Potomac Park, while the New York terminal will be situated at Belmont Park, L. I. The latter place, which has had a glorious history in the annals of American aviation, has been tendered to the Post Office Department free of any charge by its owners, the Westchester Racing Association.

The postal aerodrome of Philadelphia will be situated at Bustleton, North Philadelphia; this site comprises a tract of 130 acres, and is regarded as very advantageous. Being located at a distance from tall buildings, landing and starting will be facilitated, while it is convenient to the railroad depot at North Philadelphia and within twenty-five minutes' run by motor truck to the main post office.

With arrangements at Washington, Philadelphia and New York perfected, and the planes and aviators ready at the call of the Department, all that seems to stand in the way at present is the completion of the postal aerodromes. Hangars and other improvements are now in course of construction at all the three fields and it is confidently expected to inaugurate the service on May 15, the date last named.

Meanwhile two bills bearing on this service are pending in the Senate. One (S. 4208) was introduced by Senator Sheppard on March 28 and permits the Postmaster General, in his discretion, to require the payment of postage on mail carried by airplane at not exceeding 24 cents per ounce, or fraction of an ounce.

The other (H. R. 9414), which is known as the Post Office Omnibus bill, was passed by the House on March 26. In addition to a similar provision as to airplane postage contained in the Senate bill, it makes the following provision:

"That the Secretary of War may, in his discretion, deliver and turn over to the Postmaster General from time to time, and without charge therefor, for use in the Postal Service, such airplanes and automobiles or parts thereof as may prove to be, or shall become, unsuitable or unnecessary for the purposes of the War Department; and the Postmaster General is hereby authorized to use the same, in his discretion, in the transportation of the mails and to pay the necessary expenses thereof out of the appropriation for inland transportation by steamboat or other power boat or by airplanes or star route."

Both bills are now in the Committee on Post Offices and Post Roads.

The 1918-19 Postal Appropriation

Senator Bankhead on April 2 reported out from the Committee on Post Offices and Post Roads the bill (H. R. 7237) making appropriations for the Post Office Department for the fiscal year ending June 30, 1919.

This bill carries a total appropriation of $331,316,070, which is a decrease from $333,726,045 in the bill as passed by the House last December, which in turn was a decrease from $335,088,345, representing the estimates by the Department.

The feature of chief interest to AVIATION AND AERONAUTICAL ENGINEERING readers is the appropriation, as made by the House, of "not exceeding $100,000 for the purchase, operation and maintenance of airplanes for an experimental airplane mail service between such points as the Postmaster General may determine."

There also is a provision, which is one of the Senate Committee's amendments to the bill, authorizing the Postmaster General to fix the postage of airplane mail at not exceeding 24 cents an ounce or fraction thereof.

Another amendment made by the Senate Committee provides for the delivery to the department by the War Department of airplanes, etc., for this service.

Provision for both of the latter items has been made in the separate bills above reported which passed the House last month. The text of all the bills is virtually the same.

H. W. Johns-Manville Moves

The Youngstown, Ohio, office of the H. W. Johns-Manville Co. will be located at 520 Market Street after April 1.

New Insignia for American Aircraft

A new national insignia for all United States Government aircraft has just been adopted. This insignia is a red circle, circumscribed about inner blue circle and center white circle. The diameter of the red circle will be five feet for all airplanes having a chord length equal to or greater than five feet. In case the chord length is less than five feet the diameter of circumscribed red circle will be made equal to such chord length. The diameter of the inner blue circle will be two-thirds and the diameter of the center white circle will be one-third of the diameter of the red, circumscribed circle. The shades of red, white and blue will be the same as those used in the American flag.

One of each of these insignia will be placed on the upper surface of each upper wing in such a position that the circumference of the circumscribed circle just misses contact with the wing flap. One of each of these insignia will be placed in a corresponding position on the lower surface of each lower wing. Both sides of that portion of the rudder which is in rear of the rudder post will be painted with three equally wide bands parallel to the vertical axis of the airplane and colored red, white and blue, the red band being nearest the rudder post, the white band in the center, and the blue band at the tail of the rudder.

One of these insignia will be placed on top and one on bottom of envelope of each dirigible balloon, the center of each insignia being in a vertical plane through the longitudinal axis of the envelope. The center of the insignia on top will be at the intersection of the vertical plane with a vertical plane through the point of greatest diameter of the envelope. The center of insignia on botton will be just forward of suspension band. The circumscribed circle of the insignia for a dirigible will be 5 ft. in diameter.

The rudder of each dirigible will be marked in a manner similar to that applied to airplanes, except that stripes will not exceed 5 ft. in length or 18 in. in width. If there is more than one rudder, only the outboard side of each outboard rudder will be marked.

One of these insignia will be placed on top and one on the bottom of envelope of each captive balloon, the center of each insignia being at the intersection of a vertical plane through the longitudinal axis with a vertical plane through the greatest diameter of the envelope. The red circumscribed circle will be five feet in diameter.

For U. S. Navy free balloons there will be two distinguishing insignia five feet in diameter to be placed on the envelope, one at each end of a diameter which is inclined 45 deg. to the vertical axis of the balloon.

The designating number of each airplane and dirigible will be placed in figures 3 in. high on each side of the rudder, at the top of the white band before mentioned.

The designating number both in the case of free balloons and captive balloons will be placed on the envelope just below, or just abaft, the lower distinguishing insignia, the letter and figures to be black, three inches high and three inches below insignia. In case the color of the envelope is such that black figures are not readily distinguishable, there will be a white background with one inch margin about the designating number.

All naval aircraft will be immediately marked in accordance with the above requirements, and in future, specifications for naval aircraft will require that the contractors place the building number and distinguishing insignia on all aircraft, and on such spare parts as bear these marks in completed aircraft.

The above markings were adopted by the Joint Army and Navy Technical Aircraft Board on Jan. 11, and have received the approval of the Secretary of War and the Secretary of the Navy.

Four Hundred Photographers Wanted

A call for 400 photographers for the Photographic Section of the Air Division, Signal Corps, U. S. A., was made at Washington last week by the Provost Marshal General. The call was issued to the Adjutant Generals of several states and gives the place and date of mobilization as Madison Barracks, Sackett's Harbor, N. Y., on April 15.

Sturtevant Co. Expands

At a time when, according to newspaper accounts, the aircraft program is literally shot to pieces, due to failures, delays and changes, it is a pleasure to be able to record that the Sturtevant Airplane Co. of Jamaica Plain, Boston, is reported, on reliable authority, to be considerably ahead of its schedule for wings, tail assembly and other parts.

The company is now erecting a new two-story building which will add 30,000 odd sq. ft. to its space. New offices are also being occupied to take care of a large office organization. The force of the company has been expanded over six times in number since Nov. 1, 1917. By July 1 it is expected that it again will have doubled.

The Sturtevant Co. is probably the only airplane company which is operating under canvas. Having outgrown its present factory, the company erected a large circus tent, under which various saws and other machine tools are running full blast. The ground is covered with sawdust, and every child in the neighborhood is anxiously awaiting the arrival of the elephants and the pink lemonade.

No Licenses for Civilian Flying

The Joint Army and Navy Board on Aeronautic Cognizance made a ruling last week that no licenses whatsoever will be issued for civilian flying.

This board was appointed under the proclamation made by the President on March 4, requiring licenses to be obtained by any person who contemplates flying in a balloon, airplane, seaplane, or other aircraft after thirty days from the date of the proclamation, except aircraft operated by the Army or Navy.

On account of some of its first members having been detailed at different points because of the exigencies of war, it has become necessary to reorganize the Joint Army and Navy Board on Aeronautic Cognizance and the reorganization was effected late last week.

The membership of the reorganized board is composed of three representatives each of the Army and Navy, respectively, and is as follows: Maj.-Gen. George O. Squier, Chief Signal Officer; Col. H. H. Arnold and Lieut.-Col. C. E. Brigham, of the Signal Corps, representing the U. S. Army, and Capts. N. E. Irwin, J. R. Y. Blakeley and F. H. Clark, representing the U. S. Navy. General Squier is chairman.

Dayton-Wright Growing

One of the greatest difficulties with which airplane manufacturers have had to contend was securing an adequate supply of qualified skilled labor. The furniture, cabinet and metal working industries have been heavily drawn on for this purpose. The training of these men to the highly specialized work of airplane construction has been one of the deterrents to maximum production during the first months. A great improvement in this condition recently will have its effect.

To build up a force of over 3000 such as is now employed at the Dayton-Wright Airplane Co. of Dayton, O., has taken the best part of a year.

Plant No. 1, or the main plant located at Moraine City, has 2200 people on the payroll. Plant No. 2, located at Miamisburg, has more than 400, and Plant No. 3, located at Third and Coleman Streets, has 300. The Experimental Station, at South Field, has a few more than 100. In round numbers, there are 3000 people employed at the different plants. This number is being increased very rapidly. Recently, in four days, 600 people were added to the force. When operating to its capacity it is expected to have 7000 employes.

Liberty Loan Advertising

The publication of 16 pages of Liberty Loan advertising in this issue has been made possible by the patriotic cooperation of the following companies: Acieral Co. of America, Barcalo Mfg. Co., The Fafnir Bearing Co., L. W. Ferdinand & Co., The Fox Machine Co., Wm. Harland & Son, Walker M. Levett Co., Lanzius Aircraft Co., Grover C. Loening, Sperry Gyroscope Co., Splitdorf Electrical Co., Standard Aircraft Corp., Strauss & Buegeleisen, Thomas-Morse Aircraft Corp., Wright-Martin Aircraft Corp., Wyman-Gordon Co.

Air Service Needs Watchmakers

Fifty expert watchmakers are needed for immediate service in France in the air service repair department, according to a call sent out March 23 by Commander Grady, inspector of the Eastern Department of the Navy. First class ratings will be given men accepted for service.

Official Test of Resistal Goggles

Discussion over the relative merits of glass used in non-shatterable goggles has been ended by the official report just issued by Director S. W. Stratton of the Bureau of Standards, Department of Commerce, after tests made at the request of the National Advisory Committee for Aeronautics.

Two types of protected glass were tested—type A, one side of which is covered with a layer of celluloid, and type B, in which is welded a layer of celluloid between two layers of glass.

The object is to prevent splinters of the glass when broken from entering the eyes. Type B is the glass used in Resistal goggles, the superiority of which is attested by Director Stratton's report.

One test was made by firing bullets into the glasses from a distance of twenty-five yards. Type A glasses received a ragged hole and were badly shattered, although the celluloid film continued to hold most of the pieces of glass together. Bullets passing through type B glasses made a clean cut hole and produced cracks in each of the discs separated by the celluloid, the cracks being confined to a circular area of about two inches. All the glass except a small area around the bullet hole was firmly held by the celluloid. Ordinary plate glass when struck by a bullet flew into pieces.

The report concludes with the following strong endorsement of the type of glass used in Resistal glasses (type B):

"The relatively increased non-shatterability of laminated glass and its comparatively good transparency and rigidity even after puncture, give it great importance in devices for protecting the eyes and face."

Changes in the Liberty Engine

In the New York *World* of April 4, Frederick Upham Adams tells of investigations that he has made on the cause of delay in the production of the Liberty engine. He charges that for over six months there has been no cessation in the stream of changes in design that have been ordered. He says: "Only an official investigation can determine the actual number of constructional changes that have been ordered. There is overwhelming evidence that these changes are far in excess of 500; I examined proof that seems to indicate that these changes number more than 1000, and a competent authority informed me that the total exceeds 2000."

While the number sounds large, it must be remembered that it is usually estimated that it takes two or three years to perfect the design of an aeronautic engine, and when it is considered that announcement has been made that no more changes in design will now be made, it is assumed that the present model will be placed into fast production. It can further be said that any delay on the Liberty engine to date has not retarded the production of airplanes, for it is generally believed that the production of engines has exceeded that of the aircraft for which they were to be used.

New Model Aero Club

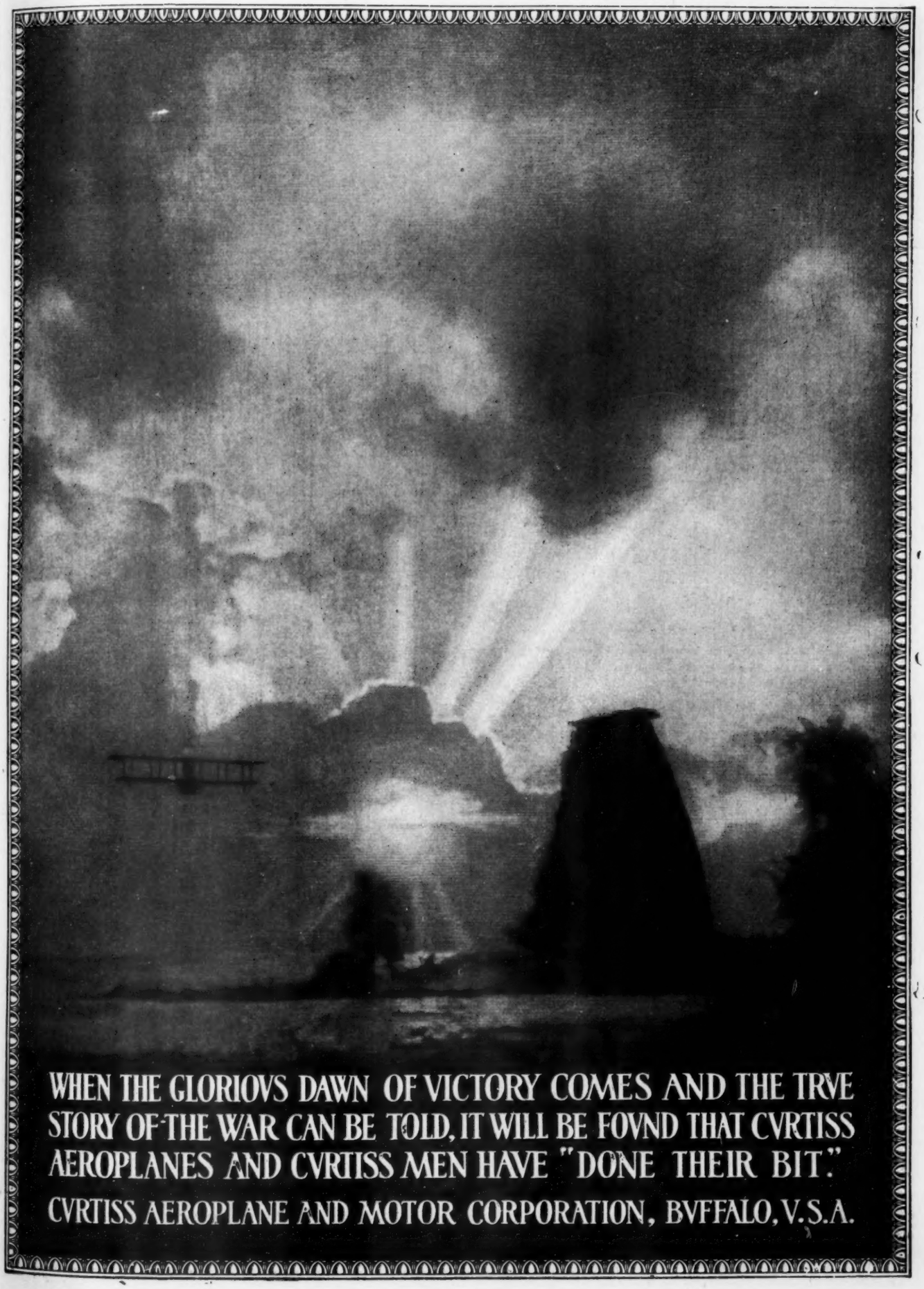
A branch of the Model Aero Correspondence Club was established in Washington, D. C., on or about Feb. 15, and is Chapter 2 of the parent organization, which is located at Babylon, L. I., N. Y., and of which Thomas Stanton is president and Edwin A. Jenkins, corresponding secretary.

The Washington Chapter has quarters at 3122 Thirty-eighth street, N. W., and the officers are: Daniel C. Long, director, and Luke C. Okna, secretary.

Attractive Liberty Loan Poster

Hammacher, Schlemmer & Co., New York, dealers in hardware, tools and supplies, have prepared a poster advertising

the new Liberty Loan. It is an attractive two-color, orange-and-black card, 11 by 21 in., and is to be placed in about 1350 street cars in and about New York.


WHEN THE GLORIOVS DAWN OF VICTORY COMES AND THE TRVE
STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS
AEROPLANES AND CVRTISS MEN HAVE "DONE THEIR BIT."
CVRTISS AEROPLANE AND MOTOR CORPORATION, BVFFALO, V.S.A.

Why Buy Liberty Bonds?

WHY do you save to build a home? It is usually cheaper to pay rent. Why do you plan to give your children a good education? Will you get any money-dividends from that?

Why do you pay fire insurance premiums and life insurance premiums? You personally will get little if anything from that.

Why do you call the doctor quickly if the children are ailing? You don't stop to think whether you can afford it. Do you?

None of these expenditures are what we call good investments. They don't pay in money, yet all pay the finest of dividends.

Liberty Bonds represent the home, the school, the children; they represent all the great deeds of our fathers and grandfathers; they represent Bunker Hill and Yorktown and Gettysburg; they represent the blessed freedom under which we all live and they also represent the ORDER that makes freedom blessed.

They represent the boys "over there"; they represent devastated Belgium and homeless Serbia and murdered Armenia.

They are the defense that shall keep from our shores the monster criminals who outraged the women of Belgium and Northern France and made the men slaves;

They represent the strength that shall restore Belgium and rebuild France and avenge Serbia;

They are the voice of those who are too young or too old or too weak to fight; they are the sword of the women and the cannon of the children; they are the voice of a free people calling to cruelly wronged, freedom-loving men and bringing them succor.

Buy them? Of course you will buy them. You'll borrow to buy them.

You don't need to be urged. You would be ashamed to go home to your children if you did not buy them.

The rate of interest is important but not of first importance. They would pay, they would appeal to you, if they bore no interest whatever.

Add to the rate of interest the dividends they pay in self-interest, in safety, in public order, in liberty and law and you have a larger return than you receive from any other thing you own.

They will never become "scraps of paper."

They are the best secured investment in the world.

You Stand Behind Them

You Should Buy Them

LIBERTY LOAN COMMITTEE
Second Federal Reserve District
120 BROADWAY, NEW YORK CITY

Gillette Safety Razor

Have You Seen the New Gillettes Specially Designed for the Fighting Man?

THESE models were designed by members of the Gillette Organization who have seen service with the Colors and know what the soldier is up against.

Hundreds of officers and men are buying them — the U. S. Service Set in metal case, and the new Khaki-covered sets for Uncle Sam's soldiers and officers.

The Gillette is the one razor for the man who is doing things — the one razor with world-wide use and reputation.

When a man wants new Blades he can get them at any Post Exchange or Y. M. C. A. Hut — here in America or Overseas.

Our Paris Office carries stocks — is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy and Eastern battle fronts.

Why the Gillette Is Especially the Soldier's Razor

THERE isn't a harder shaving job on earth than the service demanded of the Gillette by the fighting man.

Under the very worst possible conditions of climate — with cold or hard water — on sun-burned or wind-chapped faces — the Gillette is called upon for its solid-comfort, velvet-smooth shave. *And delivers it.*

There are more Gillettes used than all other kinds of razors added together— the compact, complete razor with no strops or hones to clutter up the kit.

Hundreds of thousands of officers and men have adopted the Gillette — with its blades always sharp, always ready. No Stropping, No Honing.

GILLETTE SAFETY RAZOR COMPANY

BOSTON, MASS., U. S. A.

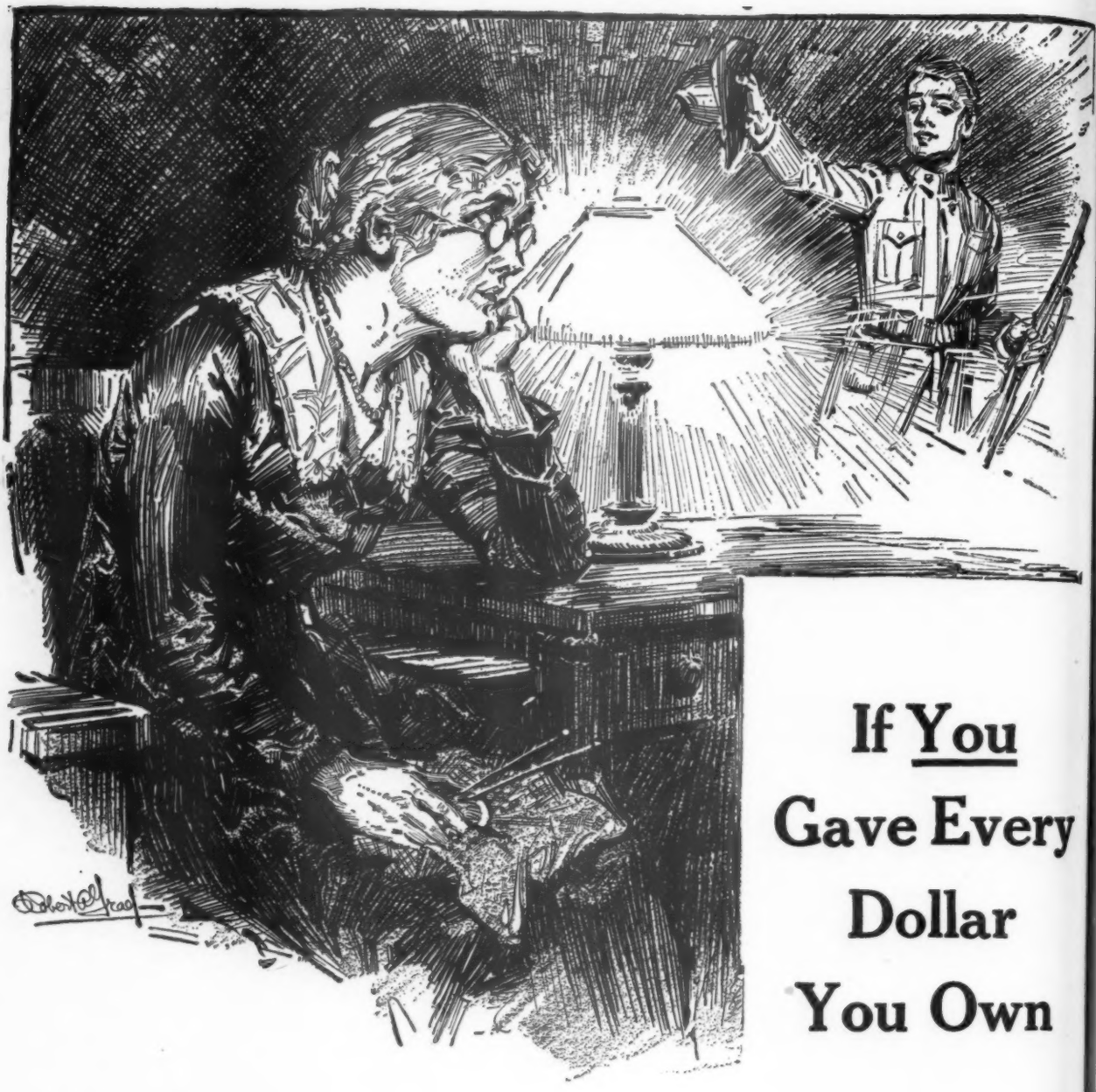
GILLETTE SAFETY RAZOR COMPANY, OF CANADA, LTD.
78 ST. ALEXANDER ST., MONTREAL

GILLETTE SAFETY RAZOR SOCIETE ANONYME
17 BIS, RUE LA BOETIE, PARIS, FRANCE

GILLETTE SAFETY RAZOR, LIMITED
200 GREAT PORTLAND ST., LONDON, W., ENGLAND

A. G. MICHELES
53 LITEINY, PETROGRAD, RUSSIA

VEDOVA TOSI QUIRINO & FIGLI
VIA SENATO, 18, MILAN, ITALY



If You Gave Every Dollar You Own

how little would the sacrifice be compared to theirs.

We are not asked to give. We are asked only to *lend*. To lend at good interest secured by the best collateral on earth

U. S. Liberty Bonds

In co-operation with the Liberty Loan Committee this advertisement is published by

THOMAS-MORSE AIRCRAFT CORP.

Ithaca, N. Y., U. S. A.

Thomas

THOMAS-MORSE AIRCRAFT CORPORATION

ITHACA, N.Y. U.S.A.

Contractors to U. S. Government

WALDEN-HINNERS COMPANY

BUILDERS OF AIRCRAFT

MILITARY AIRPLANES
SEAPLANES
FLYING BOATS

OFFICE AND FACTORY
EDGEWATER, N. J.

Choose!

"Lend Me Your Money that I may equip my Army and Navy to insure for you and your children the blessings of Liberty."

"Give Me Your Money or Your Life"

Invest now to the limit of your ability in

U. S. Liberty Bonds

The Kaiser calls us "a nation of dollar chasers." Let us show him that we know how to use those dollars in the defense of Liberty and the overthrow of Prussianism.

LANZIUS AIRCRAFT COMPANY
156 Broadway, New York

IN THE AIR

Calls for

Speed—Strength—Ease of Control

In addition to these vital requisites the new Continental Pusher offers wide range of vision for Observer, Camera Man or Gunner.

The Continental Aircraft Corporation

Factory and Aviation Field
AMITYVILLE, L. I.

New York Office
120 LIBERTY STREET

MANUFACTURERS OF

Airplanes, Experimental Airplanes and Parts

Wittemann-Lewis Model T-T, 90 h. p.

WITTEMANN-LEWIS AIRCRAFT COMPANY

NEWARK, N. J.

Main Office and Factory:

Lincoln Highway, near Passaic River

Telephone, Market 9096

The
Lanzius Variable Speed Aeroplane

Executive Offices
156 Broadway, New York City
Telephone 6668 Cortlandt

Lanzius Aircraft Company

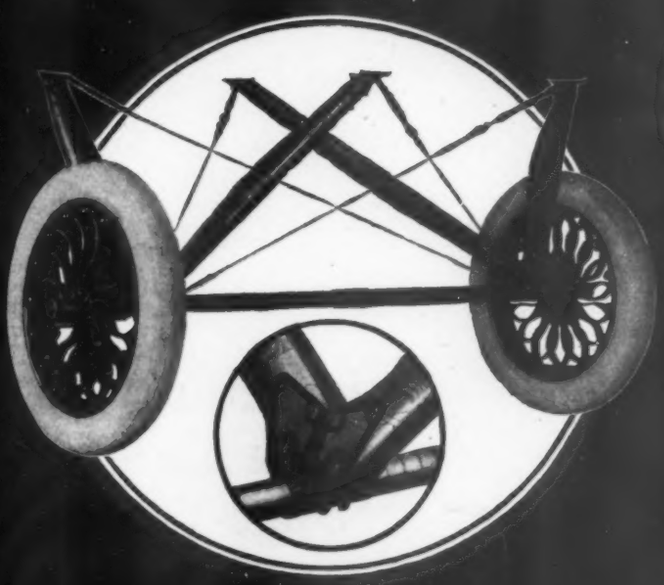
K-A-U-R-I
TRADE MARK

WATERPROOF VARNISH
KHAKI PAINT
GLOSS BLACK ENAMEL

Used on wings, hulls and pontoons by the largest airplane manufacturers and boat builders because they are most durable, elastic, waterproof and economical. On the U. S. Govt. approved list

Brooklyn Varnish Mfg. Co.

35 NOSTRAND AVE.
BROOKLYN, NEW YORK



ACKERMAN LANDING GEAR

SIMPLICITY
STRENGTH
SERVICE

THE ACKERMAN WHEEL COMPANY
542 Rockefeller Building, CLEVELAND, OHIO. U.S.A.

UNITED STATES AERO PROPELLER CO. U.S. MILWAUKEE. WIS.

UNITED STATES AERO PROPELLERS

Designed by experts. Material of the highest grade, rigidly inspected, used in their construction. Experienced workmen, with a thorough knowledge of their craft, build them. Production carried on in the largest and most efficiently equipt Aero Propeller factory in America.

Contracts now in production for the following: —
United States Government—War Department
United States Government—Navy Department
Canadian Aeroplanes Limited.

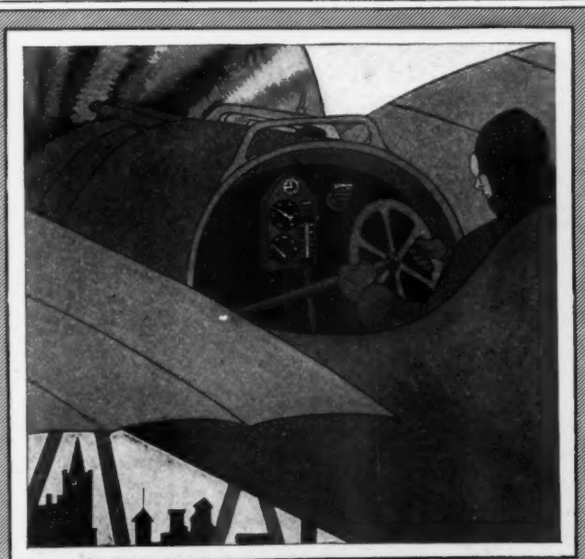
UNITED STATES AERO PROPELLER COMPANY

GENERAL OFFICES
BECHER AND GREENBUSH STREETS
MILWAUKEE - - - WISCONSIN

LUMA is the Birdman's pilot by night.

It illuminates the figures and hands of his buoyancy meter and other instruments so that they stand out as clearly and distinctly as by day.

In addition to high luminosity Luma has great permanency and is resistant to the action of moisture and atmospheric influences.



Our service is designed for the convenience and the greater economy of manufacturers of indicating instruments.

We apply Luma to dials of every description.

Our work insures the greatest attractiveness and maximum results.

Write for details.

We Use the Celebrated

LUMA

RADIUM LUMINOUS COMPOUND

RADIUM DIAL CO.

Forbes and Meyran Aves., PITTSBURGH, PA. *New York Office, 1812 Astor Trust Bldg.*

WASHERS — GASKETS — PACKING

PLUGS **FELT** **STRIPS**

ADVANCE QUALITY + SERVICE

WICKS **GROOVES**

CUTTING — PUNCHING — STRIPPING

To take up shocks—eliminate noise—save machining of metal parts—feed oil to high speed bearings—we furnish FELT parts, cut to special blueprint.

Felt value is determined by wool, hardness, resiliency, density, etc. Are you sure that the FELT now used for your parts is ***exactly suited to the purpose?*** Our Special Service Engineers will tell you — without obligation. Consultation is FREE.

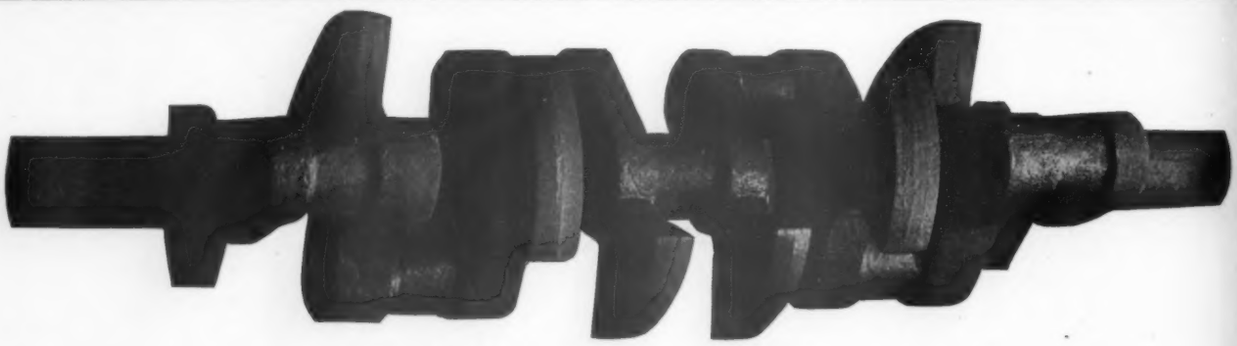
LET US STANDARDIZE YOUR SPECIFICATIONS ON FELT OR ANY OTHER RESILIENT MATERIAL

Our Engineers are here to serve you. They will estimate on your FELT or CUTTING requirments and help standardize your Felt or other ***resilient materials.*** With our own invention, a remarkable new instrument of precision —

ADVANCE FELT SPECIALTY AND CUTTING CO.

THE WIDNEY PATENT "RESILIOMETER" which positively determines ***thickness — hardness — resiliency*** of any resilient material. Send samples or blueprints for our estimate —TODAY.

MAIN OFFICE, FACTORY & LABORATORY, SO. JEFFERSON ST., CHICAGO, U. S. A.
SALES OFFICES: NEW YORK — DETROIT



a counterbalanced aviation crankshaft . . . .

Patented July 10th, 1917

one of the 18 different
models we are now making
for 14 aviation motor companies . . .

reduces vibration and eliminates bearing pressure

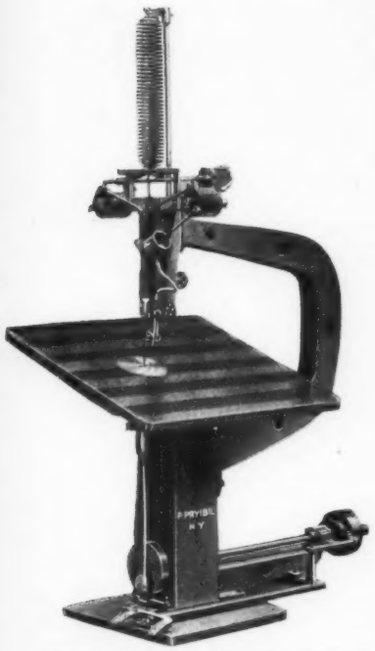
We have shipped 61,553 Counterbalanced Crankshafts to March 22, 1918

THE PARK DROP FORGE CO. CLEVELAND, OHIO

P. Pryibil Machine Company

MANUFACTURERS OF

FINE WOOD WORKING MACHINES



HIGH CEILINGS DO NOT AFFECT THIS JIG SAW

WE HAVE SERVED

CURTISS ENGINEERING CORPORATION
L. W. F. ENGINEERING COMPANY
WRIGHT-MARTIN AIRCRAFT CORPORATION
STANDARD AIRCRAFT CORPORATION
CONTINENTAL AIRCRAFT COMPANY

Why not you?

Factory, 512-524 West 41st Street, New York City
Established 1862

AIR PLANE DRY KILNS

We are prepared to design, equip, install and operate according to Aircraft Engineering Division Specification No. 20,500-A.

I. *Grand Rapids Vapor Process Kilns* (as perfected thru the erection of 2,000 kilns in high class woodworking plants).

II. *Tiemann Humidity Regulated Kilns* (as designed and developed by the Forest Products Laboratory at Madison, Wisconsin).

III. *Tiemann-Grand Rapids Combination Kilns* (combining the scientific points of the Tiemann kiln with the practical experience of the Grand Rapids Veneer Works, subject to operation by either method).

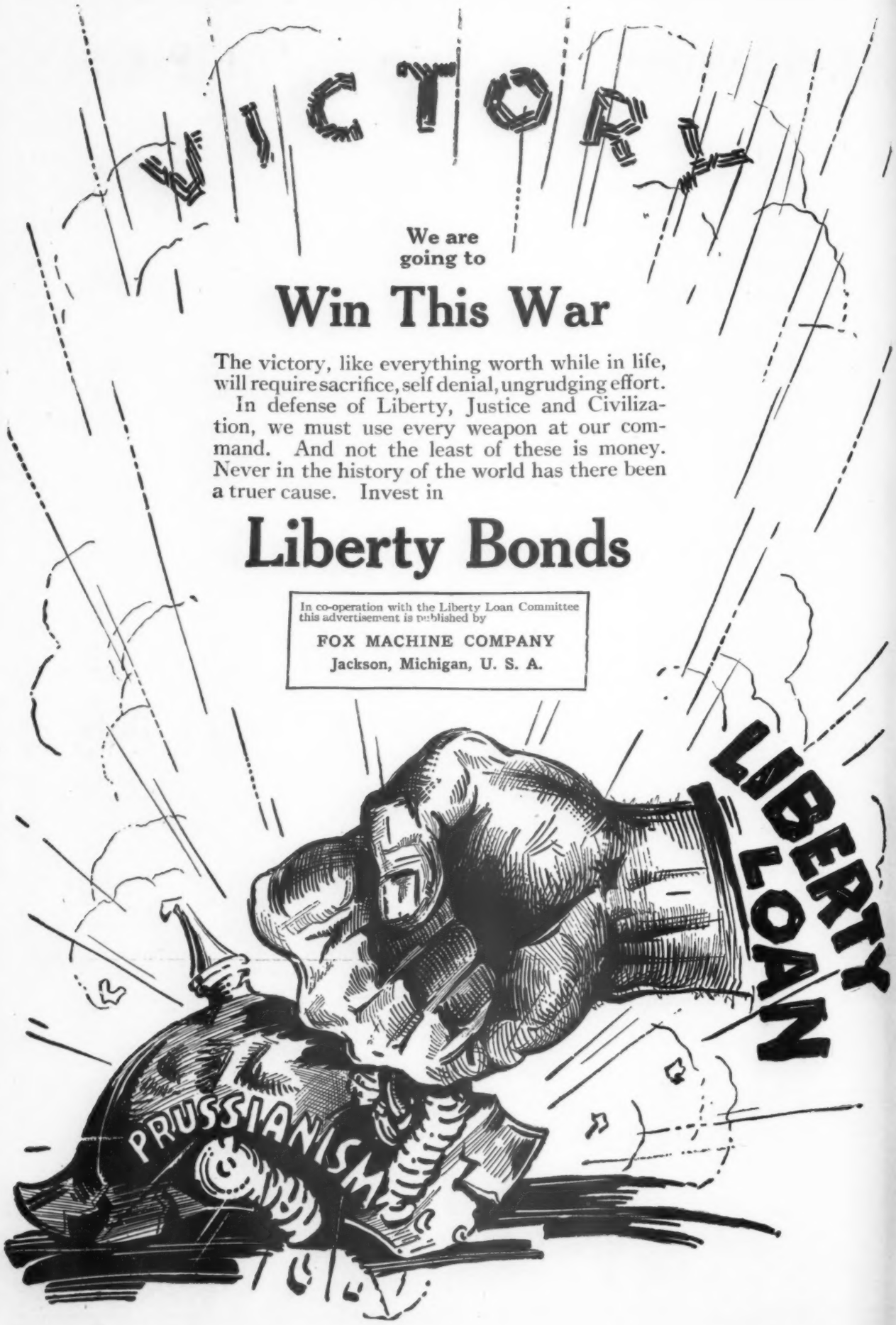
We have designed or equipped kilns for:—

STANDARD AIRCRAFT CORPORATION, 2 orders
FISHER BODY CORPORATION, 2 orders
THOMAS-MORSE AIRCRAFT CORPORATION
DAYTON WRIGHT AIRPLANE COMPANY
AMERICAN PROPELLER & MFG. COMPANY
BREESE AIRCRAFT COMPANY
BRIGGS AEROPLANE COMPANY
WEST WOODWORKING COMPANY
FLOTTORP MANUFACTURING COMPANY
GALLAUDET AIRCRAFT CORPORATION
CANADIAN AIRPLANES, LTD.
WEST VIRGINIA AIRCRAFT COMPANY

Submit your drying problem to experts who make a specialty of kiln design and are prepared to furnish and install all equipment and instruments

GRAND RAPIDS VENEER WORKS

Grand Rapids, Michigan Seattle, Washington



We are going to

Win This War

The victory, like everything worth while in life, will require sacrifice, self denial, ungrudging effort.

In defense of Liberty, Justice and Civilization, we must use every weapon at our command. And not the least of these is money. Never in the history of the world has there been a truer cause. Invest in

Liberty Bonds

In co-operation with the Liberty Loan Committee this advertisement is published by

FOX MACHINE COMPANY
Jackson, Michigan, U. S. A.

AIRPLANE ENGINE TESTING EQUIPMENTS

The Sprague Electric Works not only manufactures the testing dynamometers used by the leading airplane engine builders and by the United States Army and Navy, but offers their Engineering and Service Staff to direct the layout of test rooms and supervise the operation and conduct of tests.

The results can be demonstrated. The greatest daily production of airplane engines yet achieved has been accomplished in a plant fitted with the Sprague Electric Dynamometer System for Routine test. This plant, too, enjoys ideal indoor working conditions for the test force in all weathers and reclaims a large part of the otherwise wasted test-fuel energy.

Sprague Electric Dynamometers are available up to 800 H.P. for Engine and Propeller Testing.

Write for particulars

SPRAGUE ELECTRIC WORKS

OF GENERAL ELECTRIC COMPANY

Main Offices: 527-531 West 34th Street New York City

Branch Offices in Principal Cities

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of AVIATION AND AERONAUTICAL ENGINEERING, published semi-monthly at New York, N. Y., for April 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared George Newbold, who, having been duly sworn according to law, deposes and says that he is the Business Manager of AVIATION AND AERONAUTICAL ENGINEERING and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Publisher, The Gardner-Moffat Company, Inc., 120 West 32nd St., New York, N. Y.; Editor, H. M. Williams, 120 West 32nd St., New York, N. Y.; Managing Editor, H. M. Williams, 120 West 32nd St., New York, N. Y.; Business Manager, George Newbold, 120 West 32nd St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

The Gardner-Moffat Company, Inc., 120 West 32nd St., New York, N. Y.; William I. Seaman, Trustee for Lester D. Gardner, 120 West 32nd St., New York, N. Y.; William I. Seaman, 120 West 32nd St., New York, N. Y.; William D. Moffat, 120 West 32nd St., New York, N. Y.; Margaret K. Gardner, 120 West 32nd St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

GEORGE NEWBOLD.

Sworn to and subscribed before me this eighteenth day of March, 1918.
[SEAL.] MANGHILD A. LINDBLOM.
My commission expires March 30, 1918.

NOW READY

Bound Volume 3

OF

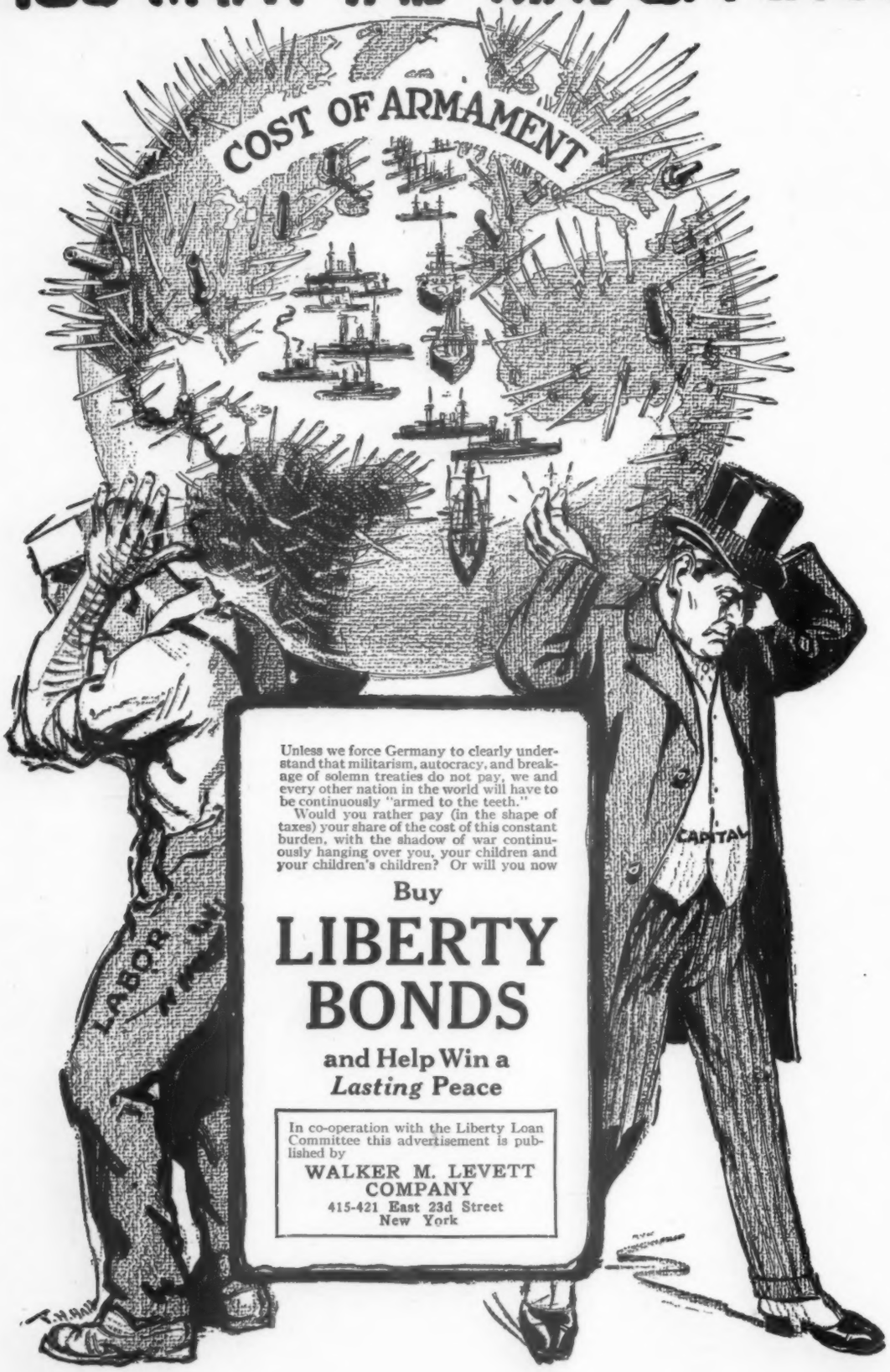
Aviation and Aeronautical Engineering

Price $5

THE GARDNER-MOFFAT COMPANY Inc.

120 West 32d Street New York

DO YOU WANT THIS KIND OF PEACE?



Unless we force Germany to clearly understand that militarism, autocracy, and breakage of solemn treaties do not pay, we and every other nation in the world will have to be continuously "armed to the teeth."

Would you rather pay (in the shape of taxes) your share of the cost of this constant burden, with the shadow of war continuously hanging over you, your children and your children's children? Or will you now

Buy

LIBERTY BONDS

and Help Win a *Lasting* Peace

In co-operation with the Liberty Loan Committee this advertisement is published by

WALKER M. LEVETT COMPANY
415-421 East 23d Street
New York

Factors of Safety

These Count in Aeroplane Construction

NON-INFLAMMABLE

Cellulose Acetate Base

Celestron Cloth Varnishes

provide another SAFETY FACTOR

NON-INFLAMMABLE

Celestron Sheets AND Films

Transparent — Waterproof

MANUFACTURED BY

Chemical Products Company

93 Broad Street **Boston, U. S. A.**

Manufacturers of Cellulose Acetate for nearly 15 years

What Country Produces the Best Aircraft?

THERE is some dispute now but eventually America must dominate the field. American brains, manufacturing facilities and natural resources make this possible.

Our individual duty is to make rubber parts for aircraft and maintain our present position in this particular field so that in the future, nearly every rubber part on American aircraft will continue to be a product of Dural laboratories and factories.

Dural

must continue to mean "everything that can be done with rubber in aircraft construction."

DURAL RUBBER CORPORATION

Flemington **New Jersey**

"USCO" NUMBER 72

THE STANDARD KITE BALLOON FABRIC OF AMERICA

A TWO-PLY BIASED FABRIC, COATED BETWEEN PLIES WITH A LIGHT, TOUGH LAYER OF PURE PARA RUBBER.

THIS FABRIC HAS BEEN DEVELOPED FROM YEARS OF LABORATORY EXPERIENCE, AND POSSESSES EVERY FEATURE AND QUALIFICATION NECESSARY TO A WELL-BALANCED PRODUCT, VIZ.:

STRONG
GAS-TIGHT
NEUTRAL, INVISIBLE COLOR
WITHSTANDS ALL WEATHER CONDITIONS
AND AGES WELL

MADE BY THE
WORLD'S LARGEST RUBBER COMPANY

UNITED STATES RUBBER COMPANY
NEW YORK

Supremacy in the Air is to be the Key to Victory!

Train yourself for service by means of our

GROUND COURSE

It gives to the student the knowledge and training needed by an ***AIRPLANE MECHANIC*** and also by the aviation student before entering the ***GOVERNMENT GROUND SCHOOL.*** Included in the course are:

Aerodynamics, presenting the reasons why an airplane actually flies. Theories and technical terms are thoroughly and simply explained, as are also the problems of lift and drift and resistance offered by various objects.

Rigging, which includes the actual taking down and assembling of the complete airplane, details of manufacture, specifications, trueing up, dividing up errors, stagger, dihedral angle, wash in and wash out—all of which must be understood by the pilot or mechanic if the best results are to be obtained with the machine. The student is taught wing repair, methods to follow when parts tear out, finishing and doping, warping and soldering loops for all kinds of wires; handling, care and maintenance of the airplane in the field, and final inspection before flight.

Lewis Gunnery, which includes the names of all parts, the action, stripping and assembling of the gun, stoppages and jams, practical handling of students, bombs, types and methods of carrying.

Artillery Observation, including maps and map reading, aerial navigation, cross country flying.

Airplane Engines, including everything in the Special Airplane Engine Course noted below.

Equipment—All necessary appliances are provided for instruction work.

Among the equipment are two complete airplanes, spare parts and tools; Lewis machine gun and spare parts, and engines of the Curtiss O. X., Gnome, Hall-Scott, Daimler, etc., and numerous engine parts. There are Bosch, Eisemann and Dixie magnetos, and Rayfield, Schebler and Zenith carburetors.

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See Index to Advertisers on page 421

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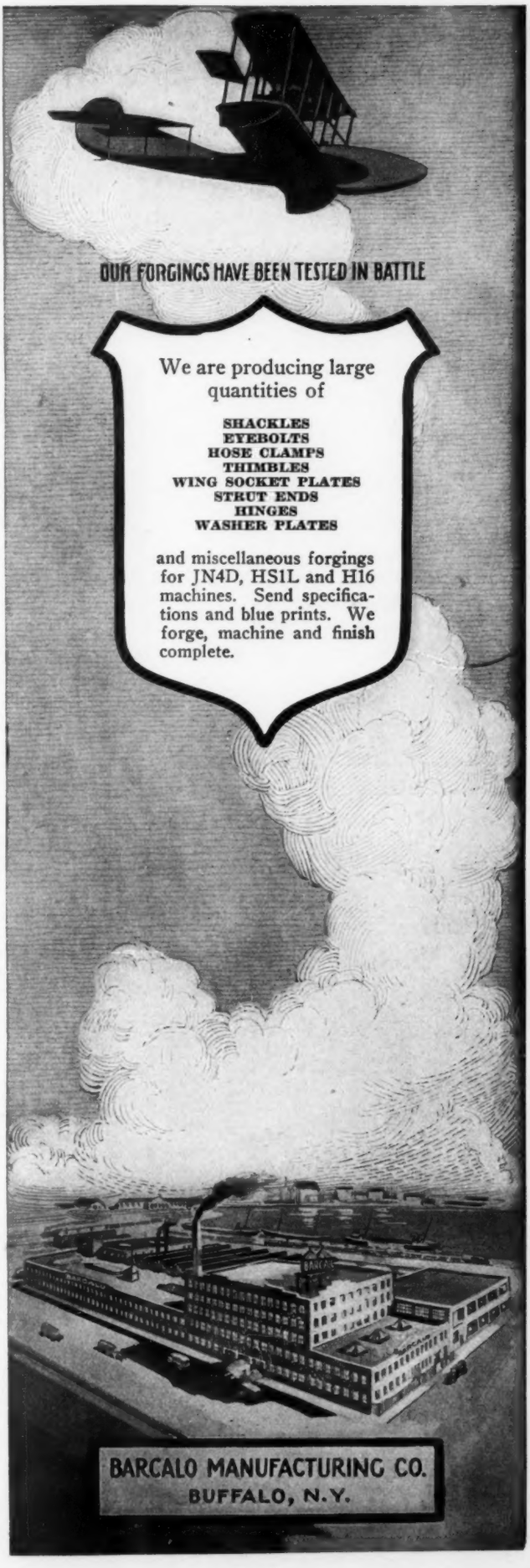
(*Continued on page 409*)



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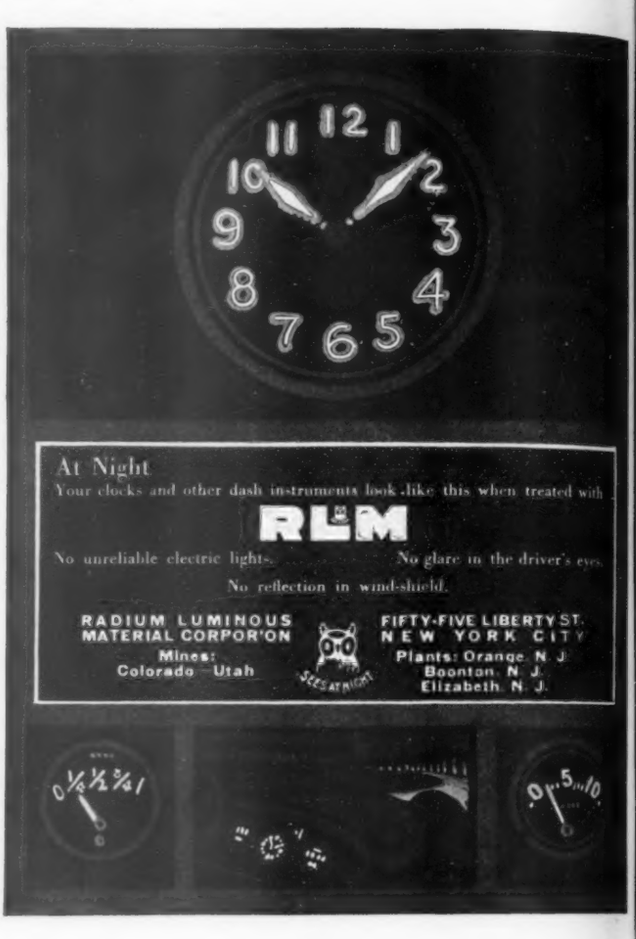
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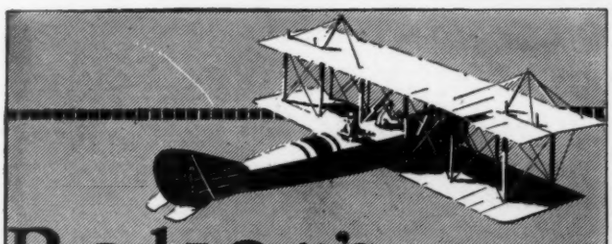

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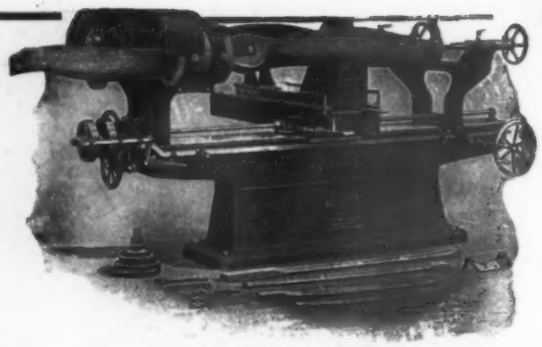

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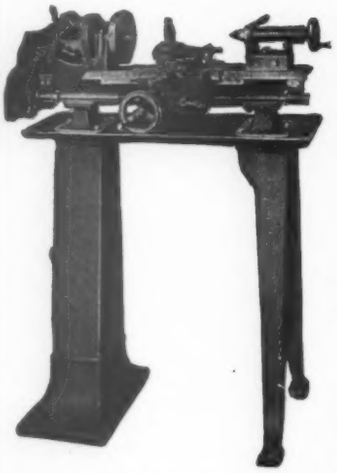

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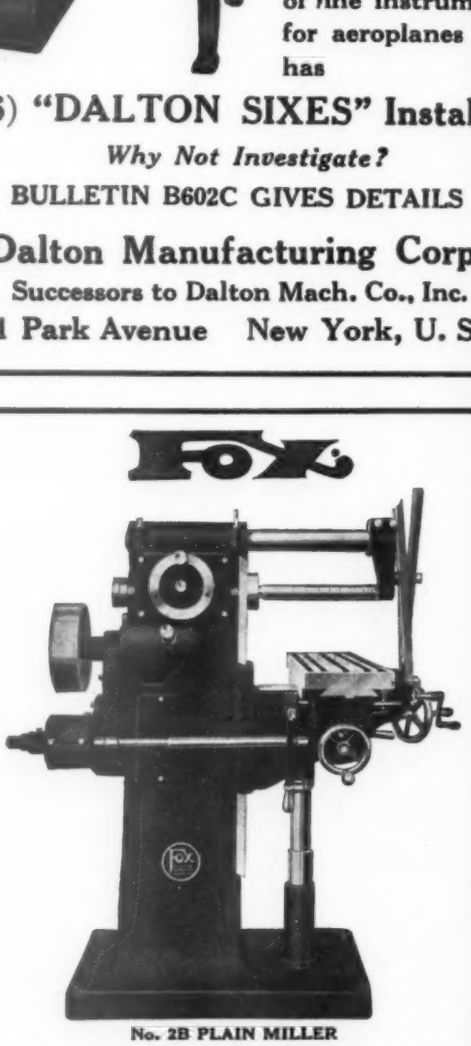

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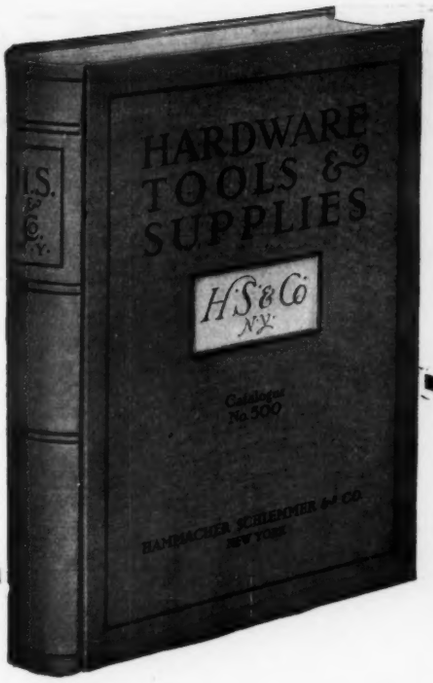

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(Continued from page 411)

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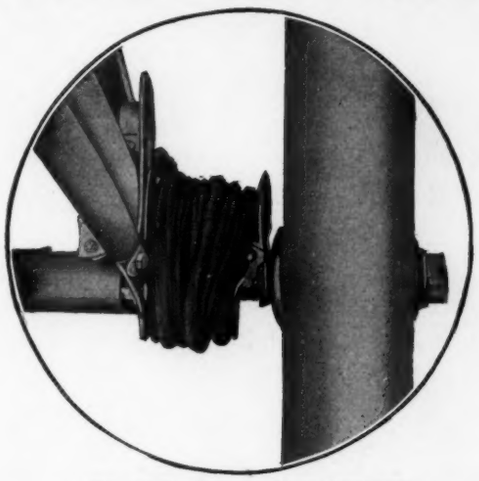

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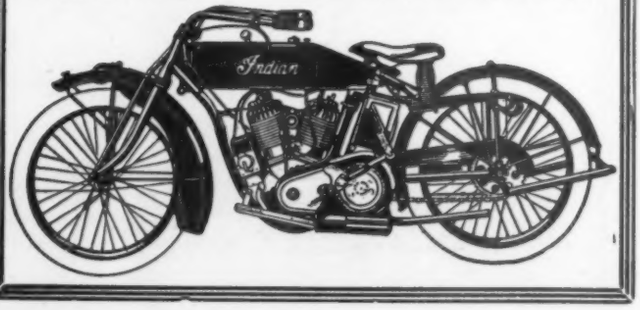

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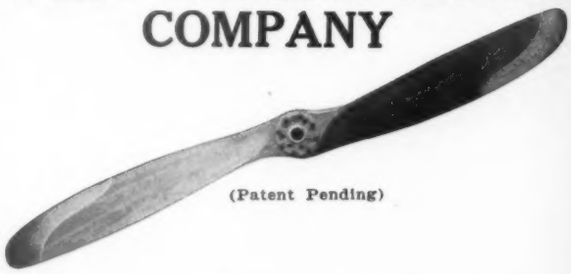

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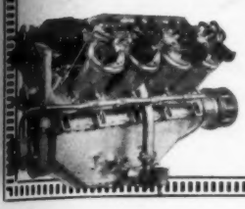

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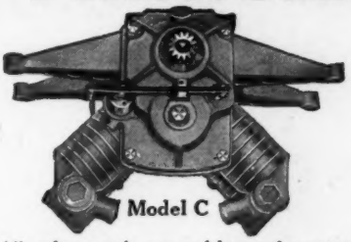

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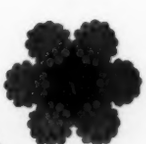

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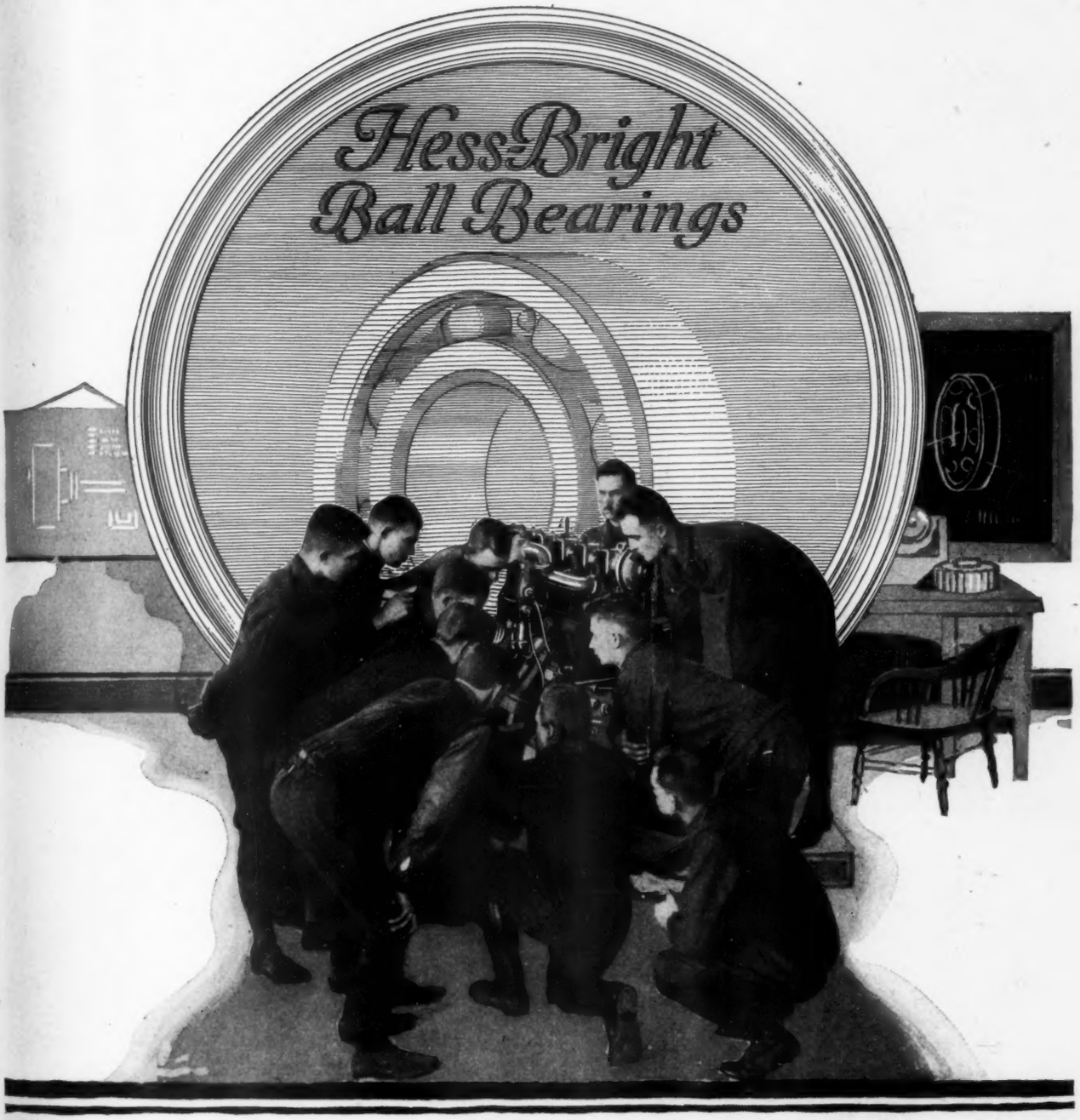

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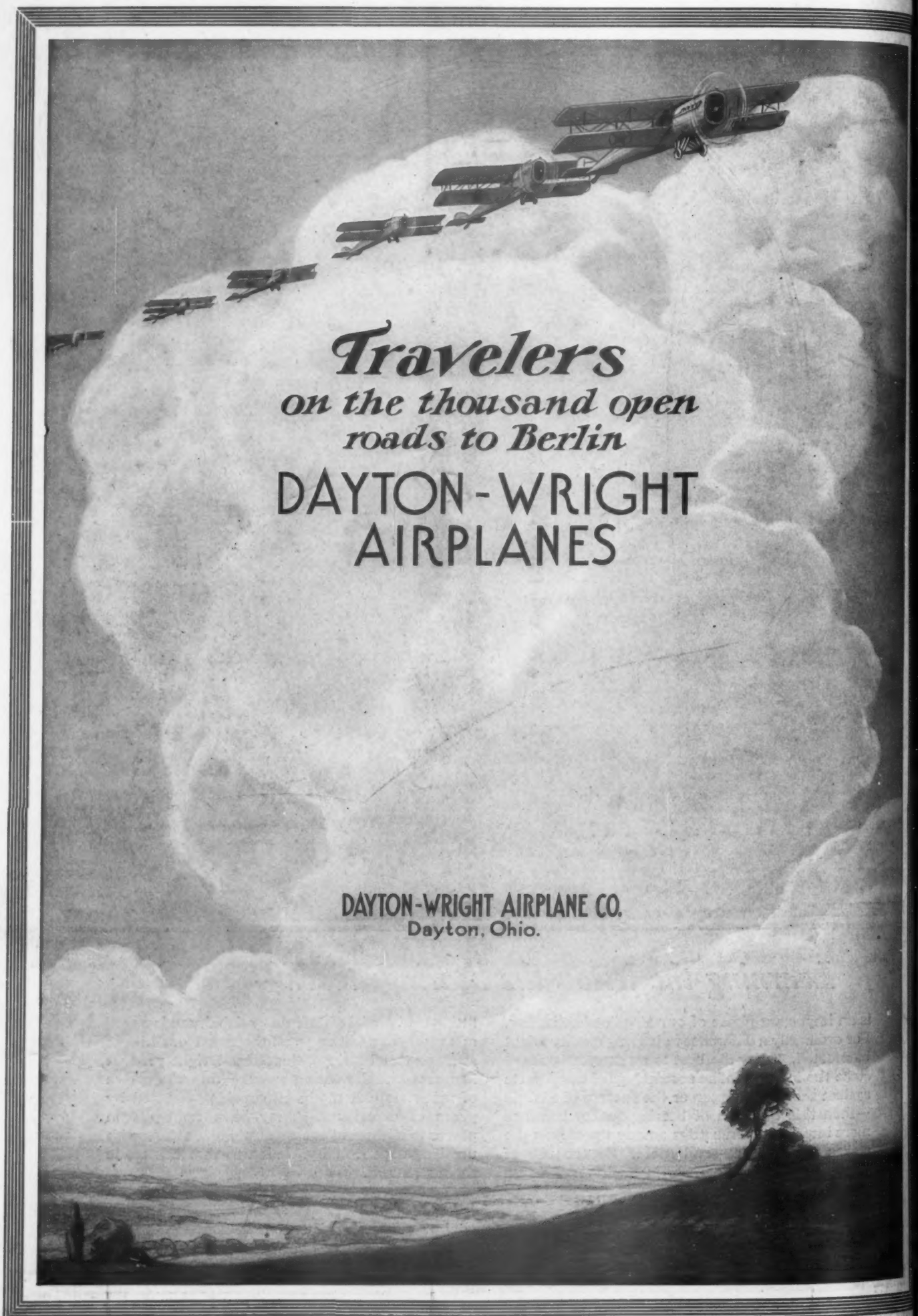
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